American Journal
of
ORTHODONTICS

VOL. 37 | DECEMBER, 1951 | No. 12

Original Articles

THE EFFECTS OF THE PHYSICAL CONSISTENCY OF FOOD ON THE GROWTH AND DEVELOPMENT OF THE MANDIBLE AND THE MAXILLA OF THE RAT

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INTRODUCTION

THERE are diverse opinions concerning the effects of function on the form of the bones of the jaws. Some writers[8, 12, 13, 24, 33] consider that the form and the size of the jawbones are determined by inherent genetic factors, and that environmental conditions are not significant influences. Others[1, 3, 41, 46, 51, 60] maintain that functional stimulus is an important consideration, and that without this stimulus jawbones will not develop to their fullest extent.

The studies of Keith[25] have been very important in this regard. In comparing the people of the Neolithic period with the present population of Britain, he stated:

> There is a decided tendency (in modern people) to crowding and irregularities of the teeth, and to a narrowing and elongation of the face—a tendency to produce a face of a hatchet-shaped pattern. The nose is narrow and the palate contracted, and the vault is high. The teeth are not worn down as in Neolithic men; they are very liable to be attacked by caries. The front teeth when the jaws are closed, do not meet edge to edge as in primitive races; like the blades of scissors, they overlap, the lowers passing behind the uppers.

What is the reason for these changes? Klatsky[27] believes that the physical character of food, in contrast to its chemical or nutritional elements, and the manner in which it is eaten have an important influence on the growth and development of the jaws, and that the high incidence of dental disease is caused by the soft, nonstimulating diets that are consumed by the majority of civilized people.

It is necessary to define the term "function," for it may be used with several different meanings. It may be employed to indicate the internal physiological processes within the constituent cells of an organ, or it may simply refer

This manuscript was awarded first prize by the Research Committee of the American Association of Orthodontists for 1951. It was presented to the Association in April, 1951.

to the general "use" of that organ. In this article the second definition is implied. Thus, in speaking of the mandible and maxilla, the bones of particular interest in this study, it is the functional stimulus of mastication and its effect on development that is of prime interest.

The experimental work discussed in this paper was undertaken to study the relative effects on the growth and development of the mandible and maxilla of the rat of indolent as compared to vigorous masticatory function. Are the broad, well-developed arches of primitive races the result of increased function, or are they due to their hereditary background? Or, conversely, is the frail development of the supporting structures of the teeth of modern people the result of their soft, nonstimulating, highly refined diets?

REVIEW OF THE LITERATURE

The review of the literature can be discussed under three headings:

a. General observations.
b. Observations on primitive people.
c. Experimental evidence.

a. *General observations:* The attentions of many investigators have been directed toward a study of the effects of function on the form of bones. Wallace[50, 51] for many years has been an ardent advocate of the beneficial effects of a detergent diet. In fact, he maintains that a soft, refined diet that requires little mastication not only leads to a physical deterioration of the teeth and jaws but is also detrimental to the whole digestive system. In the field of orthodontics, Roger[41] considers that by increased function, arrested or retarded development may be stimulated toward the normal. He stated,[42] ". . . the ultimate form and structure depend on the nature and degree of function the individual is able to bring into use." He applies this principle in the treatment of malocclusions, but it is difficult to assess, from an examination of his cases, just how much benefit is obtained from myofunctional therapy and how much from simply unlocking the bite and allowing the jaws to assume a normal relationship.

Periodontists have also recognized the importance of function, and adequate masticatory load within physiological limits is considered an important prerequisite to periodontal health. Stillman and McCall[46] consider that a deficiency of alveolar structure is a primary etiological factor in certain periodontal lesions. They think this deficiency is due either to heredity or to a lack of vigorous function. Box[6] also maintains that heavy function leads to good development of the supporting bone, while lack of function causes a resorption of the trabeculae and a replacement by fatty marrow. This is the opinion of Kronfeld[29] for he stated, "The greater the functional stress, the stronger and denser is the supporting bone. In the case of lack of function the supporting bone is almost entirely missing; only the thin outer and inner plates are present."

Many of these observations are based on a consideration of extremes of function, heavy function and lack of function, and the emphasis is on a change

in the density of the bone. Lack of function leads to osteoporosis; increased function, to osteosclerosis. These changes conform with Wolff's law, which states that not only is the internal architecture of a bone dependent on the strength and direction of the stresses applied to it, but also its outer form is fully adapted to the mechanical forces acting upon it. Examples of the validity of the second half of this statement are given by Weinmann and Sicher.[54] They described deformities of the skeleton, such as coxa valga of the femur and scoliosis of the spine, resulting from paralysis of certain groups of muscles. Also they mentioned the condition of pes planus, a deformity of the tarsal bones of the foot, which results from a relaxation of the associated ligaments.

It would appear from the foregoing evidence that changes in the functional stresses can cause an alteration of the internal architecture and the outer form of bones. This adaptability of bone tissue is characteristic, no matter where it is found. However, this is by no means a universal opinion. Brash,[8] MacMillan,[33] and Brodie[13] believe that the form and size of a bone is predetermined by hereditary factors and that an alteration in function can only bring about a change in the density of the bone. Murk Jansen's[24] hypothesis is that the form of bones being given, the bone elements place or displace themselves in the varied direction of functional pressure.

Certain abnormal conditions in man have been investigated which add to the study of this problem. Ivy[23] presented a case of pseudoanodontia in which all the teeth developed but none erupted, so that occlusal function was absent. There appeared to be no evidence of underdevelopment of the jaws. Similarly, cases of true anodontia have been reported[4, 30, 43, 47] in which the mandible has developed normally in length without the function or eruption of the teeth. But where there is an absence of muscular function as in cases of ankylosis of the temporomandibular joint there is a marked underdevelopment of the mandible.[47] Therefore, it would appear that muscular function together with the resultant increased blood supply is an important factor in the development of the mandible. This is not the case with the maxilla, however, for Thoma[47] reported that in anodontia the maxilla tends to be underdeveloped while in ankylosis of the joint it appears to attain normal size. In the maxilla, therefore, muscular function is not so important and Thoma considers the stimulus of nose breathing the major influence.

However, these opinions are based on clinical evidence alone and it is not known what the degree of development of the jaws would have been had the abnormal conditions not been present. Therefore these findings tend to be inconclusive.

b. *Observations on primitive people:* Important evidence has been gained from a study of the dentitions of primitive races. Excellent studies have been made by Campbell[14] on the Australian aboriginal, by Keith[26] on the British people of the Neolithic and early Bronze periods, Waugh[53] and Williams[59] on the Eskimo, Pickerill,[40] who has studied the Maori of New Zealand, and by many others. These investigations have all tended to show that primitive people possessed very efficient and healthy dentitions and that dental disease was practically limited to individuals of advanced years. Their dental arches were

broad and well developed, the supporting bone massive and dense, and the teeth were regularly arranged, showing, in the adult, marked occlusal and interproximal wear.

These conditions have been compared with modern dentitions by Hooton[22] who remarked that when an anthropologist is confronted with a skeleton of unknown identity, the first part he looks at is the teeth because they give a good indication of the owner's mode of life. On this point, he said:

If a person was a civilized adult, his teeth are likely to show little abrasion of the enamel from wear, but many caries, alveolar abscesses, and gaps caused by teeth lost in life, with frequent crowding, maleruption and reduction in the size of the dental arches. On the other hand, if the teeth are erupted in their proper positions so that they occlude normally; if there are no evidences of decay, if the crowns of the teeth (in the case of middle aged or elderly persons) are deeply worn so that the cusps are eroded away and the dentine exposed, the anthropologist is likely to conclude that he has to do with the remains of an "uncivilized" person.

The dietaries of primitive people have also been investigated.[15, 17, 27, 34] From a nutritional point of view, their diets were inadequate. They depended entirely on natural foods, the choice of which varied with the seasons. Their diets were not well balanced and lacked variety, and this may be a factor in their short life span and smallness of stature. On the other hand, their food was fibrous and resistant and generally required vigorous mastication. They were not conversant with the culinary arts of civilization and their food was prepared in a crude manner. Waugh[53] described how the Eskimo's meat is hung in the sun and becomes very tough, and how the women soften raw hides with their teeth. He observed marked wear and suggested that, "Vigorous chewing of food is beyond question the great factor in jaw development." However, he referred only to the alveolar bone for he again said, ". . . we have come to believe that the size of the body of the jaw is determined largely by heredity, and the form, quantity and size of the alveolus is primarily the result of function."

Is there any relationship between the well-developed dentitions of primitive races and the vigorous function they employ? It appears that this is just another example of the validity of Wolff's law, a physiological alteration in the form and structure of the jaws due to the heavy functional stresses imposed upon them. But it may be argued that the massive jaw development of primitive people is not the result of increased functional stimuli, but is inherent in the individual. Brash,[9] in speaking of the Eskimo, suggested that no serious evidence has been brought forward to show that their jaws do not develop their characteristic form in the absence of vigorous function, and that normal development probably takes place within a wide range of functional activity. However, Williams,[59] studying the Eskimo, showed various degrees of malarrangement of the teeth in those who have come under the influence of civilization. Campbell[15] also observed in the present-day Australian aboriginal, who has been brought up under civilized food habits, ". . . advanced caries and 'broken-down' dental arches in natives by no means advanced in years."

c. *Experimental evidences:* Many experimental investigations have been designed to demonstrate the influence of function on the growth and form of the jaws. All these experiments are similar in one respect; by mutilation, that

is, removing or grinding down the teeth, or interfering with the muscular activity exerted on the jaws, one of the factors concerned with the growth of the jaws is interfered with, while all other conditions supposedly remain the same. This is difficult to do, because a change in one factor will undoubtedly affect the delicate balance that exists between all the other factors that may influence the growth of the jaws. And then, too, must be considered the special conditions introduced by injury or trauma, for these are known to affect the metabolism of the part.[58] Therefore, these experiments cannot directly prove or disprove any hypothesis, but they can only indirectly support or discredit it.

One of the earliest experiments in this field was performed in 1864 by Sedillot, and is reported by Thompson.[48] Sedillot removed the greater part of the shaft of the tibia in puppies, leaving the whole weight of the body resting on the fibula. The latter bone is normally about one-fifth or one-sixth of the diameter of the tibia. But under the stimulus of increased load, the fibula grew until it was as thick or even thicker than the removed bone.

A few years later Darwin[16] reported a somewhat similar study to show the effect of function on development. He demonstrated that in half lop-eared rabbits there was an asymmetrical development of the skull and jaws. Walkhoff,[49] by removing a portion of the left temporal muscle in dogs, produced a similar result. Experiments of this type suggest that muscular activity is an important stimulus in the development of the jaws and cranium.

Sheldon Friel[19] described the mandible of an Irish elk, in which the teeth were more worn on the right side than on the left. The animal, it was thought, suffered from rheumatoid arthritis and mastication was greater on one side than the other. Measurements were made and it was found that, ". . . certain areas, especially the length of the tip of the coronoid process to the angle of the mandible, were appreciably larger on the side on which the teeth were worn." Also, "The x-ray photograph does not show any great difference in density on the two sides." Brash[10] pointed out, in discussing this mandible, that asymmetry may have been originally present, and may not be due to differences in the amount of function on the two sides.

Baker has made a noteworthy contribution in this field. His first experiment[1] was performed on a litter of four rabbits. He interfered with the forces of occlusion on two animals, by grinding down all the teeth on the right side of the mandible and the upper right incisor. After seven months, he noted the asymmetrical development of the bones of the skull and of the mandible. Greater bony development in the mandible was observed on the side under the influence of masticatory function than on the other side, and also, there was lack of development of the condyle on the side without functioning teeth (Fig. 1).

Baker weighed the skulls of the animals and he stated, ". . . both the work-on skulls weighed much less than the normal skull," but because of the small number of animals used his figures hardly substantiate his claim.*

*Baker's[1] figures are as follows:

WEIGHT OF ANIMALS		WEIGHT OF SKULLS	
Control	1,631 grams	Control animal	248 grams
First operated on	1,478 grams	First operated on	227 grams
Second operated on	1,735 grams	Second operated on	243 grams

Bebbs[5] criticized this work of Baker's, in that no fixed points of measurements were taken, the number of animals used was too small, and no normal variation of the rabbit's crania was established.

Similar experiments have been carried out by Baker on the dog, cat, and sheep.[2] He illustrated the mandible of a dog, in which he "successfully eliminated the function of the teeth of the left lateral half of the maxillae," either by extraction or grinding, no details being given. Baker did not state for what length of time the experiment was carried out, but the removal of the upper teeth had an interesting effect on the lower jaw, as shown in Fig. 2. There appeared to be very frail development of the supporting bone about the mandibular teeth on the nonfunctioning side, and Baker said, ". . . these nonfunctioning teeth were beginning to show signs of loosening."

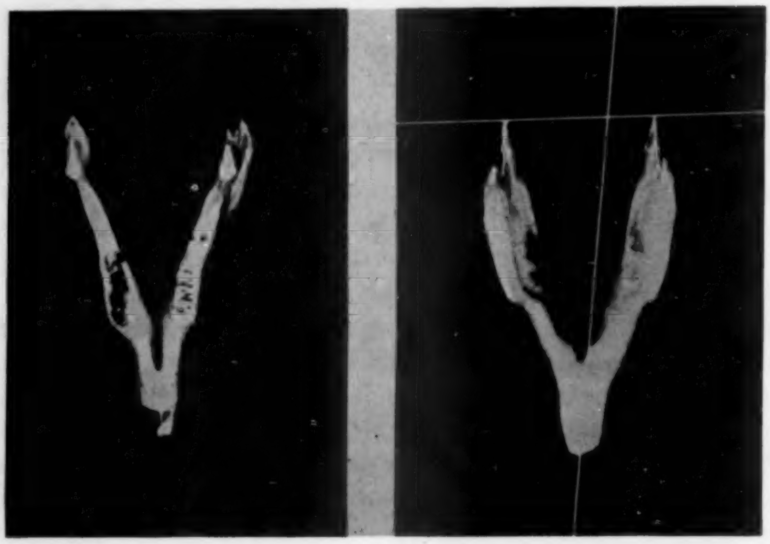


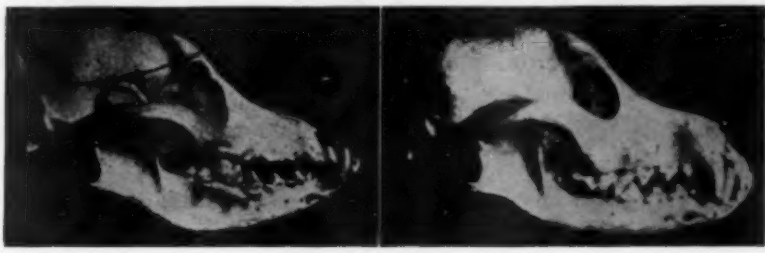
Fig. 1.—The mandible of a rabbit, in which the teeth on the right were ground down. There is an asymmetrical development of the mandible as a result of an interference with the forces of mastication. (Baker, L. W.: INT. J. ORTHODONTIA 8: 259, 1922.)

Very similar experiments have been performed by Landsberger,[31] who submitted evidence which seems to indicate that the presence of teeth is necessary for the normal development of the jaws. He removed on one side of the jaw of a dog, either upper or lower, all the tooth germs of the deciduous and permanent teeth. At the end of a year, he found that the growth of the skull on the operated side had been seriously affected. He observed not only a lack of development of the alveolar bone, but also a curvature of the upper jaw to the operated side.

In the same paper, Landsberger described another dog's skull in which all the tooth germs were removed from the maxillae, and in another contribution[32] he removed all the mandibular tooth germs. These experiments provide an opportunity to observe the effects of a minimum amount of masticatory function on the unoperated jaw. His illustration showing the effect of "loss of function" on the mandible is very similar to Baker's (Fig. 3). There is

poor development of the alveolar bone about the mandibular teeth. Unfortunately, no measurements are available in either Baker's or Landsberger's reports to show any dimensional changes in the jaws.

Fig. 2.—Mandible of a dog in which the teeth on the upper left side had been removed. Note the lack of development of the supporting bone around the lower left molar teeth. (Baker, L. W.: INT. J. ORTHODONTIA 8: 259, 1922.)



A. B.

Fig. 3.—The dogs' skulls as illustrated by Landsberger. In *A*, all the upper teeth were removed soon after birth, while the skull in *B* is a control. There is a lack of development of the alveolar bone of the mandible of the experimental skull as compared with the control. (Landsberger, R.: Dental Cosmos 66: 1334, 1924.)

These experiments all tend to show that removal or grinding of the teeth, thereby interfering with the muscles of mastication, will affect the growth of the jawbones. This must be due either to a lack of the eruptive influence of the teeth, or to a loss of masticatory function, or even to the effects of trauma produced by the operative procedure. Probably all three factors combine to produce the effect.

That bones will differentiate and grow without the influence of function has been shown by many investigators. Murray and Huxley[36] grafted a small

basal piece of the left posterior limb-bud of a 4-day-old chick on the chorio-allantoic membrane of a 7-day chick. After seven days the result was "a highly differentiated and very easily recognized femur." Fell and Robison[18] obtained similar results, in vitro, by the cultivation of chick embryo femur rudiments in suitable media. These observations show that bones will develop their primary anatomical forms even when removed from their normal developmental environment.

Baker[3] performed the following experiment: Three days before birth, a rat's mandible was removed and transplanted into the leg muscle of a young female rat. It was allowed to remain there for forty days. The transplanted mandible grew and differentiated into a recognizable mandible, which was about half the size of a mandible taken from a litter mate rat of the same age. Not only was the influence of masticatory function removed from the transplanted bone, but it also grew in a changed environment in respect to its pH and blood supply. These factors must have influenced its development.

However, it does appear that while the inherent developmental forces are very strong, bones will not develop to their fullest extent without the stimulus of masticatory function.

EXPERIMENTAL PROCEDURE

The experiment was conducted on two groups of rats. Group I consisted of sixty weanling rats whose body weight averaged 51 grams at the commencement of the study. Group II was composed of forty adult rats whose initial body weight averaged 433 grams.

The experimental procedure for Group I was as follows: thirty-two male and twenty-eight female weanling rats, approximately 21 days old, were divided into two groups. The pairing was governed by sex, litter, and by weight of the animals. Pairing by weight was considered advisable because of the variation in their initial weights (Table I). Thus, two groups of equal number, with sixteen males and fourteen females in each group, were formed.

The rats in one group were fed hard Master Fox Breeding Cubes which, with water supplied separately from a standard bottle, constituted a nutritionally adequate diet. These cubes were made by grinding the constituents finely, treating them with steam, and consolidating the mixture by forcing it through a die under pressure to form a compressed, dry, crunchy cube. The rats in the other group were given the same food after it had been ground to a fine powder (mesh, 64 to the inch) and mixed with water, in the proportion of 20 Gm. of powder to 40 c.c. of water, to form the consistency of gruel. In every case this ground material came from the same batch as the cubed material, the only difference being that some of the cubes were ground to the flourlike consistency. One group will be referred to as the hard diet group and the other as the soft diet group.

In order to ascertain whether the two groups had the same caloric intake, four pairs of male rats and four pairs of female rats were fed in pairs. In each pair the rat receiving the hard food was supplied with an excess, the weight of the amount eaten was determined, and this same amount of food

was supplied and was consumed by its mate on the soft diet. Thus, the pairs consumed the same amount of food throughout the experiment. The remainder of the animals were fed ad libitum. The rats were weighed each week. It was found that there was no significant difference in the weights of the "pair fed" animals with those fed ad libitum, nor between the animals fed the hard diet and those fed the soft diet (Fig. 4). Therefore, taking their gain in weight as a criterion for food consumption, it may be assumed that the caloric intake of the soft diet group was the same as the hard diet group.

TABLE I. BODY WEIGHTS OF THE ANIMALS AT THE BEGINNING AND END OF THE EXPERIMENT. GROUP I

HARD DIET GROUP			SOFT DIET GROUP		
ANIMAL NUMBER	INITIAL WEIGHT (IN GRAMS)	WEIGHT WHEN SACRIFICED (IN GRAMS)	ANIMAL NUMBER	INITIAL WEIGHT (IN GRAMS)	WEIGHT WHEN SACRIFICED (IN GRAMS)
1M1	52	364	1M2	52	340
1M3	44	306	1M4	52	336
1M5	52	354	1M6	52	366
1M7	58	306	1M8	54	290
2M9	54	282	2M10	56	296
3F11	54	184	3F12	58	198
3F13	58	202	3F14	66	228
4M15	82	350	4M16	70	318
4F17	66	184	4F18	64	208
5F19	52	224	5F20	50	230
5F21	46	220	5F22	44	200
6M23	56	310	6M24	62	380
7M25	70	380	7M26	72	378
8F27	74	236	8F28	70	216
9M29	58	342	9M30	58	364
9F31	50	196	9F32	52	180
9F33	62	200	9F34	64	190
10F35	48	224	10F36	48	202
10F37	52	220	10F38	52	198
10F39	48	196	10F40	48	226
10M41	56	346	10M42	58	414
10M43	52	386	10M44	56	416
11M45	56	364	11M46	58	316
12M47	52	292	12M48	52	332
12F49	60	234	12F50	54	213
12F51	62	208	12F52	62	226
13F53	50	224	13F54	52	210
13M55	54	324	13M56	54	308
13M57	54	368	13M58	60	370
13M59	50	354	13M60	52	314
Mean	46	279		57	282

The animals gained in weight very well throughout the experiment. They appeared very healthy and it was felt that the diet was nutritionally adequate. Therefore, these two groups of animals lived in the same environment except for one factor, the physical consistency of the food they ate.

The experimental procedure for Group II was essentially the same. Forty adult male rats whose body weight averaged 433 grams were divided by weight into two experimental groups of equal number. Pairs of rats of approximately equal weight were selected and were assigned to one or other of the groups at random. The animals were about 9 months old at the beginning of the study.

These animals were all of the same stock and of about the same age and were reared under identical circumstances on the hard Master Fox Breeding

Cubes. One experimental group, the hard diet group, continued eating these same cubes, while the other group, the soft diet group, were given the same food after it had been ground to a flourlike consistency and mixed with water

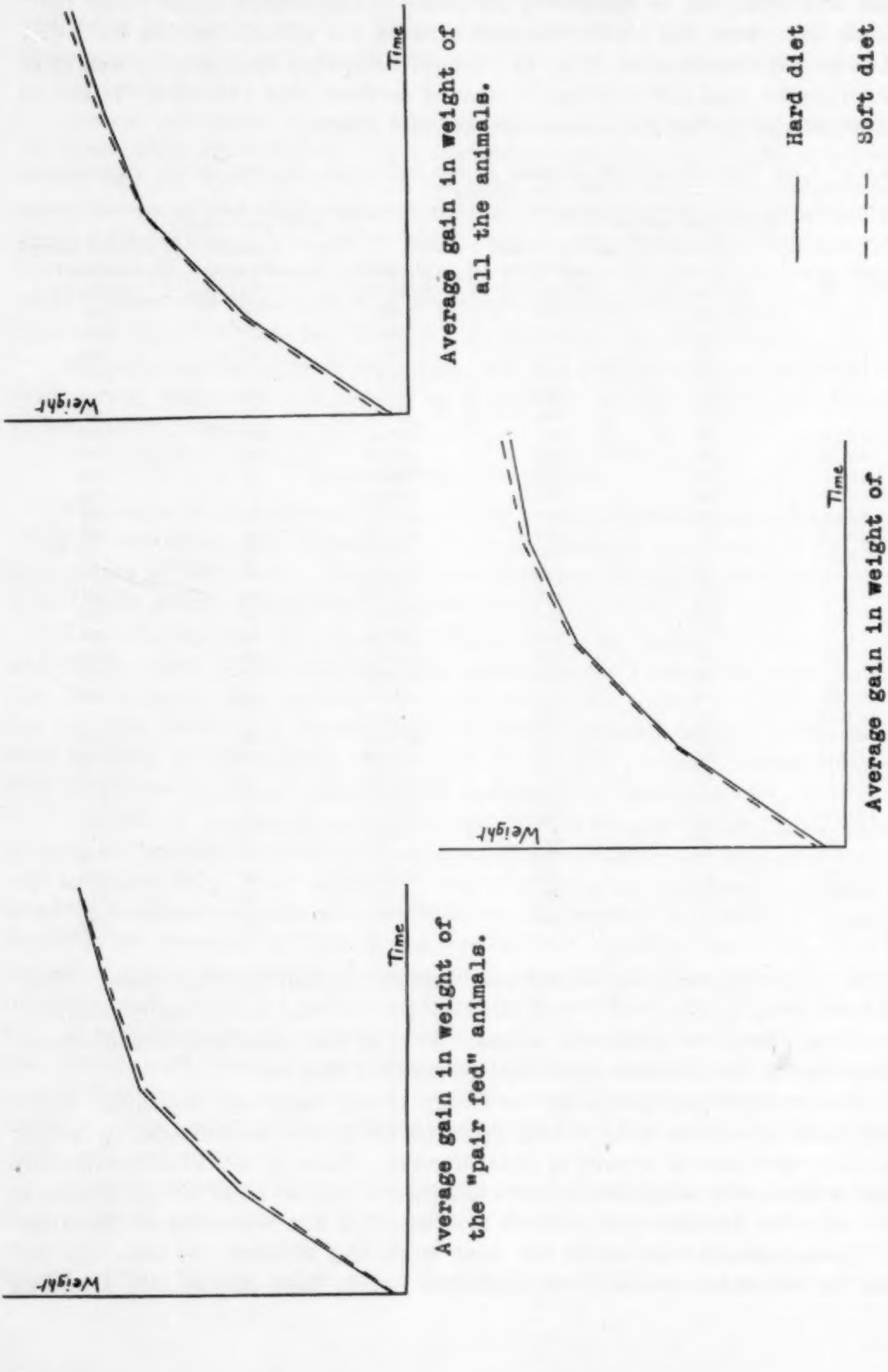


Fig. 4.—Growth curves of the male animals in Group I. The similarity of the curves is striking. The growth curves of the female animals produced similar characteristics.

to form a mush. In every case the ground material came from the same batch as the cubed material.

All the animals were fed ad libitum. This procedure was considered justifiable on the basis of the experience gained in the study of Group I animals. The animals were weighed every two weeks and it was found that the mean gain in total body weight during the experimental period was 53 grams (Fig. 5, Table XI). It will be observed that the soft diet group gained more in weight than the hard diet group, but statistically this difference was not significant. The t value for this difference,* based on an analysis of the difference between the mean weights, was 1.60.

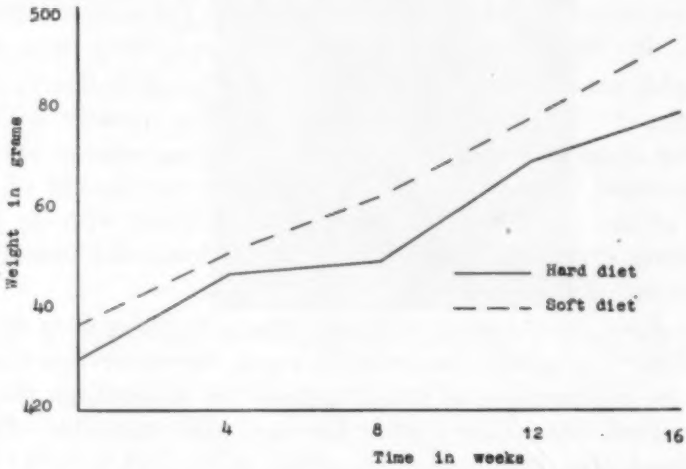


Fig. 5.—The average gain in weight of the Group II animals.

One animal died during the course of the experiment and its mate in the other experimental group was discarded. Therefore, the final observations were based on an analysis of 38 rats, 19 in each group.

After four months, which constituted the main growth period for the Group I animals, the animals were sacrificed. The left sides of the mandibles were removed and prepared for microscopic study. The right sides of the mandibles were carefully dissected out and then defleshed in a pressure cooker, using a constant time and temperature for all the mandibles. The skulls of the animals were also defleshed and prepared for study. The bones were oven-dried overnight and the following observations and measurements were made in respect to:

a. Wear of the teeth.
b. Radiographic observations.
c. Weight, volume, and density of the mandibles.
d. Thickness of the mandibles.
e. Planimetric analysis.
f. Angle formed by the occlusal plane and a line drawn through the most dependent points of the mandible.
g. Width of the maxillae.

*The critical value of t at the 0.05 probability level for 36 degrees of freedom is 1.96.

FINDINGS*

1. *Group I Observations.—*

a. *Wear of the teeth:* No wear was observed on the occlusal surfaces of the molar teeth of the soft diet group. In the hard diet group the wear was most prominent on the first molar, the cusps being almost obliterated, less obvious on the second molar, where the cusp height was reduced by about half, and still less on the third molar, where the tips of the cusps were just worn through to the dentine. Using Stein's[45] classification, the wear of the first molar had reached approximately stage 7, the second molar, stage 6 and the third molar, stage 5 (Figs. 6 and 7).

There was no apparent change in the pitch of the occlusal plane as a result of wear. In both groups a typical Monson's pitch was observed.

b. *Radiographic observations:* All the mandibles were radiographed using a constant technique.† The radiographs were examined directly with a high-power magnifying glass and also indirectly by studying photographic prints that had been enlarged three times. No difference in the density of the bone between the two groups could be established by this method, with the exception that the articulating surfaces of the condyles of the hard diet mandibles were denser than in the soft diet mandibles.

c. *Weight, volume, and density analysis:* The mandibles were dried in an oven and immediately weighed. In order to avoid any error that might have occurred due to the reabsorption of moisture from the atmosphere, the soft diet mandible was weighed immediately after the hard diet mandible of the same pair. It was found that except in three cases, pairs 1M3/4, 10M41/42, and 12M47/48, the hard diet mandible was heavier than the soft diet mandible. On the average, the hard diet mandible was 0.028 gram or 8.42 per cent heavier than the soft diet mandible. A t test of significance‡ was applied to

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*No caries was found in any of the teeth of either the hard diet or soft diet animals.

†*Radiographic technique:* All the mandibles were radiographed on four 7 inch by 10 inch films. The film was placed in a thin paper film holder which was backed by a lead screen to minimize scattered radiation. The jaws were arranged flat on the film holder.

Target distance	6 ft.	Time	8 sec.
K.V.P.	34	Film	Eastman's No-Screen.
M.A.	10	Development time	6 sec.

‡In the statistical analysis of all the differences in the data, the t test was used. Because the experiment was set up in pairs, the test was applied to the differences between individual pairs. The following values were used:

$$t = \frac{\bar{d}}{S_{\bar{d}}}$$

N = number of observations.

$\bar{d}$ = mean difference.

$$\text{where } S_{\bar{d}} = \sqrt{S_d^2\left(\frac{1}{N}\right)}$$

$S_{\bar{d}}$ = standard error of the mean difference.

$$\text{where } S_d^2 = \frac{S(d^2) - \frac{(Sd)^2}{N}}{N-1}$$

S_d^2 = variance of the difference.

DISTRIBUTION OF t

n	PROBABILITY OF A VALUE FALLING OUTSIDE THE LIMITS ± t				
	0.5	0.1	0.05	0.01	0.001
18	0.69	1.73	2.11	2.88	3.93
29	0.68	1.70	2.04	2.76	3.66
∞	0.67	1.64	1.96	2.58	3.29

n = number of degrees of freedom.

Fig. 6.—An occlusal view of a pair of rats' mandibles from Group I, showing the degree of wear of the occlusal surfaces of the molar teeth. The hard diet mandible is on the left.

Fig. 7.—A lingual view of the same pair of mandibles as in Fig. 6. The cusps of the first molar tooth of the hard diet mandible have been almost obliterated.

the data, resulting in a t value of 7.35. Therefore, the difference in the weights of the mandibles is a significant one (Tables II and III).

TABLE II. SUMMARY OF THE WEIGHT, VOLUME, AND DENSITY ANALYSIS. GROUP I

	HARD DIET ANIMALS	SOFT DIET ANIMALS	$\bar{d}$	PERCENTAGE d	t
Average weight	0.3655 gram	0.3371 gram	0.028 gram	8.42	7.35
Average volume	0.228 c.c.	0.212 c.c.	0.016 c.c.	7.55	6.52
Average density	1.61 gram/c.c.	1.60 gram/c.c.	0.01 gram/c.c.	0.62	1.25

TABLE III. WEIGHTS OF THE DRIED MANDIBLES. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	WEIGHT OF MANDIBLE (IN GRAMS)	ANIMAL NUMBER	WEIGHT OF MANDIBLE (IN GRAMS)	d (IN GRAMS)
1M1	0.4213	1M2	0.3762	0.045
1M3	0.3808	1M4	0.3856	0.005
1M5	0.4253	1M6	0.3949	0.030
1M7	0.3766	1M8	0.3335	0.043
2M9	0.3400	2M10	0.3192	0.021
3F11	0.3132	3F12	0.2864	0.027
3F13	0.3450	3F14	0.3394	0.006
4M15	0.4010	4M16	0.3471	0.054
4F17	0.3180	4F18	0.3079	0.010
5F19	0.3135	5F20	0.3042	0.009
5F21	0.3330	5F22	0.2812	0.052
6M23	0.3928	6M24	0.3635	0.030
7M25	0.4148	7M26	0.3922	0.023
8F27	0.3342	8F28	0.3282	0.006
9M29	0.4103	9M30	0.3584	0.052
9F31	0.3196	9F32	0.2793	0.040
9F33	0.3168	9F34	0.2941	0.023
10F35	0.3472	10F36	0.2869	0.060
10F37	0.3340	10F38	0.2936	0.040
10F39	0.3304	10F40	0.3091	0.021
10M41	0.3942	10M42	0.4067	–0.012
10M43	0.4128	10M44	0.3922	0.021
11M45	0.3966	11M46	0.3704	0.026
12M47	0.3622	12M48	0.3719	–0.010
12F49	0.3326	12F50	0.3066	0.026
12F51	0.3303	12F52	0.3058	0.024
13F53	0.3717	13F54	0.3171	0.055
13M55	0.3762	13M56	0.3442	0.032
13M57	0.4106	13M58	0.3867	0.024
13M59	0.4114	13M60	0.3309	0.080
Mean	0.3655		0.3371	0.028

The volumes of the mandibles were estimated by immersing them in a small jar containing mercury. The displacement of the mercury was read on a tube, calibrated to 1/100 c.c., attached to the stopper of the jar (Fig. 8). Again, the volumes were measured in pairs, to avoid error which might result if temperature variation changed the mercury volume. The volume data are presented in Tables II and IV, and in many respects are very similar to the data pertaining to the weights of the mandibles. With the exception of six pairs, the hard diet mandible was greater in bulk than the soft diet mandible. For only 3 pairs, 1M3/4, 10M41/42, and 12M47/48, both the weight and the volume of the soft diet mandibles were greater than the hard diet mandible.

The mean volume of the hard diet mandibles was 0.016 c.c., or 7.55 per cent greater than the soft diet mandibles. The t value was 6.52, and therefore the difference in volume is significant.

It was observed that the difference in the weights and volumes of the mandibles was of the same order, and also, where the difference in weight in the individual pairs was great, the difference in volume was correspondingly large. This observation led to a density analysis, for density may be defined as weight per unit volume. Therefore, by dividing weight by volume, a figure of the average density of the mandibles was obtained (Tables II and V). This figure was remarkably constant for all the mandibles, and the difference between the two groups was almost negligible. The average difference amounted to 0.01 gram/c.c. or 0.62 per cent. Statistically, this difference is not significant, the t value being 1.25, which lies between the 0.5 and 0.1 probability level.

Fig. 8.—The apparatus used in determining the volume of the mandibles.

d. *Thickness of the mandibles:* The total buccolingual thickness of the mandible was measured in the region of the distal root of the first molar tooth, midway vertically along the root. The measurements were made with a microm-

eter fitted with pointed ends. This allowed an accurate reading to be taken at a definite point. The results of this analysis are given in Table VI. With the exception of pair 6M23/24, the buccolingual thickness of the mandible of the hard diet animal was greater than the thickness of the mandible of the soft diet animal. The mean difference was 0.006 inch. The t value was very large, being 10.2. The thickness of the mandibles of the hard diet group is, therefore, significantly greater than the soft diet group.

TABLE IV. VOLUMES OF THE MANDIBLES. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	VOLUME OF MANDIBLE (IN C.C.)	ANIMAL NUMBER	VOLUME OF MANDIBLE (IN C.C.)	D (IN C.C.)
1M1	0.26	1M2	0.23	0.03
1M3	0.24	1M4	0.24	0.00
1M5	0.25	1M6	0.24	0.01
1M7	0.23	1M8	0.21	0.02
2M9	0.22	2M10	0.20	0.02
3F11	0.20	3F12	0.18	0.02
3F13	0.21	3F14	0.21	0.00
4M15	0.25	4M16	0.22	0.03
4F17	0.19	4F18	0.19	0.00
5F19	0.19	5F20	0.18	0.01
5F21	0.20	5F22	0.17	0.03
6M23	0.24	6M24	0.23	0.01
7M25	0.25	7M26	0.24	0.01
8F27	0.21	8F28	0.21	0.00
9M29	0.26	9M30	0.23	0.03
9F31	0.20	9F32	0.18	0.02
9F33	0.20	9F34	0.19	0.01
10F35	0.22	10F36	0.18	0.04
10F37	0.21	10F38	0.19	0.02
10F39	0.20	10F40	0.19	0.01
10M41	0.25	10M42	0.26	-0.01
10M43	0.26	10M44	0.25	0.01
11M45	0.25	11M46	0.23	0.02
12M47	0.23	12M48	0.24	-0.01
12F49	0.21	12F50	0.19	0.02
12F51	0.21	12F52	0.19	0.02
13F53	0.23	13F54	0.20	0.03
13M55	0.24	13M56	0.22	0.02
13M57	0.26	13M58	0.24	0.02
13M59	0.26	13M60	0.21	0.05
Mean	0.228		0.212	0.016

e. *Planimetric analysis:* The planimeter is an instrument for measuring area. For the purpose of making this analysis, a three-times enlargement was made of the radiograph of each mandible. The mandible was divided into three areas by drawing a perpendicular from a line passing through the most dependent points of the bone to the distal aspect of the distal root of the third molar tooth. This line was continued along the distal surface of this root to the superior border of the ramus. Similarly, a perpendicular was drawn to the mesial aspect of the mesial root of the first molar tooth and this line was continued along the mesial root surface to the superior bone edge. Thus the mandible was divided into three portions, designated *A, B,* and *C* (Fig. 9). Area *A* occupied the posterior portion of the mandible and was largely under the influence of the muscles of mastication; area *B* included the molar teeth,

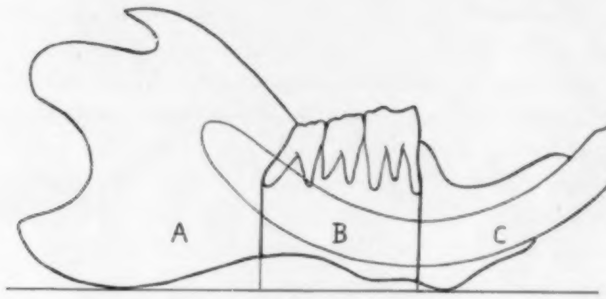

Fig. 9.—This diagram illustrates the method of dividing the mandible into the three areas, *A*, *B*, and *C*.

Fig. 10.—The angle formed by the occlusal plane and the inferior border of the mandible.

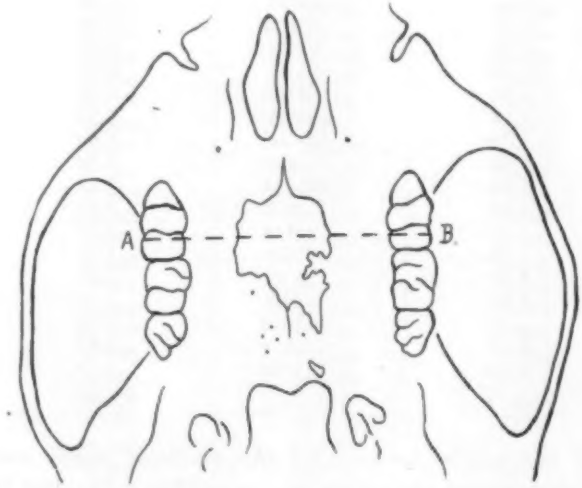

Fig. 11.—Drawing of a rat's maxilla. The width of the maxilla was measured between points *A* and *B*.

a portion of the incisor and the supporting bone; area *C* contained the anterior portion of the incisor tooth and its supporting bone. This division was designed to ascertain more accurately in which portion or portions any change in area may have taken place.

A mean of two readings of each area was taken. These data are presented in Table VII. An analysis of the differences is presented in Table VIII. There was no significant difference in areas B and C between the two groups, their *t* values being 1.60 and 1.50, respectively. There was a significant difference in area A which was greater in the hard diet group than in the soft diet group. On the average, area A of the hard diet mandible was 0.030 sq. in., or 6.5 per cent greater than area A of the soft diet mandible. The *t* value for this difference is 4.62 and is, therefore, statistically significant. There was a simi'ar difference in the total area of the buccal aspect of the mandible to that of area A (Table IX).

TABLE V. AVERAGE DENSITY OF THE MANDIBLES. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	DENSITY OF MANDIBLE (IN GRAMS/C.C.)	ANIMAL NUMBER	DENSITY OF MANDIBLE (IN GRAMS/C.C.)	D (IN GRAMS/C.C.)
1M1	1.62	1M2	1.64	-0.02
1M3	1.59	1M4	1.61	-0.02
1M5	1.70	1M6	1.64	0.06
1M7	1.64	1M8	1.59	0.05
2M9	1.55	2M10	1.60	-0.05
3F11	1.57	3F12	1.59	-0.02
3F13	1.64	3F14	1.62	0.02
4M15	1.60	4M16	1.58	0.02
4F17	1.67	4F18	1.62	0.05
4F19	1.65	5F20	1.69	-0.04
5F21	1.66	5F22	1.65	0.01
6M23	1.64	6M24	1.58	0.06
7M25	1.66	7M26	1.63	0.03
8F27	1.59	8F28	1.56	0.03
9M29	1.58	9M30	1.56	0.02
9F31	1.55	9F32	1.55	0.00
9F33	1.58	9F34	1.55	0.03
10F35	1.58	10F36	1.59	-0.01
10F37	1.54	10F38	1.55	-0.01
10F39	1.65	10F40	1.63	0.02
10M41	1.58	10M42	1.56	0.02
10M43	1.59	10M44	1.57	0.02
11M45	1.59	11M46	1.61	-0.02
12M47	1.57	12M48	1.55	0.02
12F49	1.58	12F50	1.61	-0.03
12F51	1.57	12F52	1.61	-0.04
13F53	1.62	13F54	1.59	0.03
13M55	1.57	13M56	1.56	0.01
13M57	1.58	13M58	1.61	-0.03
13M59	1.58	13M60	1.58	0.00
Mean	1.61		1.60	0.01

f. *Analysis of the angle formed by the occlusal plane and a line drawn through the most dependent points of the mandible:* During the study of the photographic prints taken from the radiographs of the mandibles, it was observed that there was a difference between the two groups in the angle formed by the occlusal plane and a straight line drawn through the most dependent

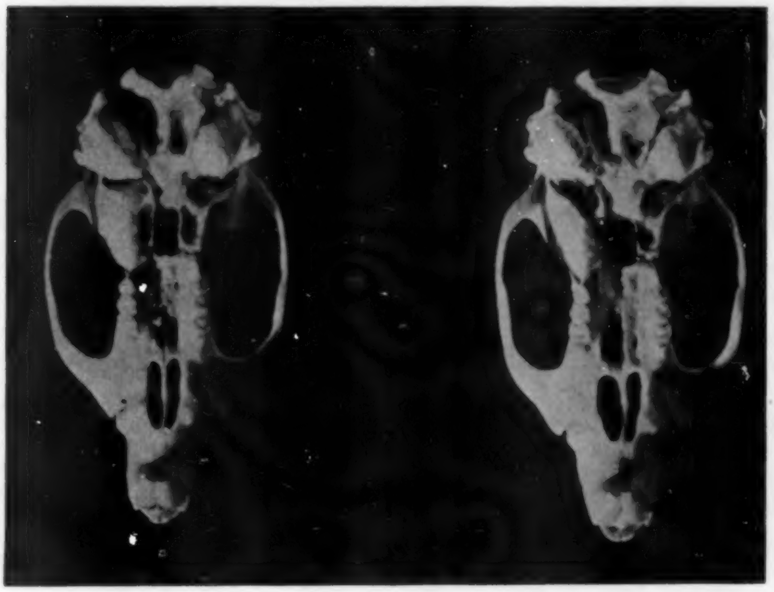

Fig. 12.—An occlusal view of a pair of rats' skulls from Group I. The width of the maxilla of the hard diet animal, on the right, is greater than that of the soft diet animal.

TABLE VI. THICKNESS OF THE MANDIBLES. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	WIDTH OF ALVEOLAR BONE (IN INCHES)	ANIMAL NUMBER	WIDTH OF ALVEOLAR BONE (IN INCHES)	D (IN INCHES)
1M1	0.094	1M2	0.088	0.006
1M3	0.094	1M4	0.093	0.001
1M5	0.096	1M6	0.090	0.006
1M7	0.094	1M8	0.091	0.003
2M9	0.096	2M10	0.084	0.012
3F11	0.091	3F12	0.083	0.008
3F13	0.091	3F14	0.088	0.003
4M15	0.097	4M16	0.089	0.008
4F17	0.096	4F18	0.087	0.009
5F19	0.090	5F20	0.082	0.008
5F21	0.092	5F22	0.084	0.008
6M23	0.093	6M24	0.093	0.000
7M25	0.098	7M26	0.091	0.007
8F27	0.092	8F28	0.089	0.003
9M29	0.095	9M30	0.087	0.008
9F31	0.088	9F32	0.082	0.006
9F33	0.086	9F34	0.083	0.003
10F35	0.095	10F36	0.084	0.011
10F37	0.092	10F38	0.083	0.009
10F39	0.090	10F40	0.085	0.005
10M41	0.098	10M42	0.094	0.004
10M43	0.102	10M44	0.095	0.007
11M45	0.098	11M46	0.095	0.003
12M47	0.091	12M48	0.089	0.002
12F49	0.092	12F50	0.087	0.005
12F51	0.094	12F52	0.088	0.006
13F53	0.090	13F54	0.089	0.001
13M55	0.095	13M56	0.090	0.005
13M57	0.094	13M58	0.087	0.007
13M59	0.094	13M60	0.082	0.012
Mean	0.094		0.088	0.006

TABLE VII. AREA ANALYSIS. GROUP I

HARD DIET GROUP					SOFT DIET GROUP				
ANIMAL NUMBER	AREA A (SQ. IN.)	AREA B (SQ. IN.)	AREA C (SQ. IN.)	TOTAL AREA (SQ. IN.)	ANIMAL NUMBER	AREA A (SQ. IN.)	AREA B (SQ. IN.)	AREA C (SQ. IN.)	TOTAL AREA (SQ. IN.)
1M1	0.56	0.29	0.21	1.06	1M2	0.54	0.27	0.19	1.00
1M3	0.52	0.28	0.20	1.00	1M4	0.56	0.28	0.21	1.05
1M5	0.59	0.28	0.21	1.08	1M6	0.53	0.29	0.21	1.03
1M7	0.50	0.29	0.20	0.99	1M8	0.49	0.29	0.20	0.98
2M9	0.49	0.25	0.20	0.94	2M10	0.47	0.26	0.19	0.92
3F11	0.41	0.23	0.18	0.82	3F12	0.39	0.23	0.17	0.79
3F13	0.43	0.26	0.18	0.87	3F14	0.43	0.26	0.17	0.86
4M15	0.55	0.29	0.20	1.04	4M16	0.50	0.26	0.19	0.95
4F17	0.45	0.25	0.18	0.88	4F18	0.43	0.26	0.18	0.87
5F19	0.45	0.26	0.17	0.88	5F20	0.43	0.26	0.18	0.87
5F21	0.46	0.26	0.18	0.90	5F22	0.39	0.23	0.17	0.79
6M23	0.52	0.28	0.20	1.00	6M24	0.48	0.27	0.19	0.94
7M25	0.52	0.27	0.20	0.99	7M26	0.49	0.28	0.20	0.97
8F27	0.45	0.25	0.19	0.89	8F28	0.43	0.26	0.19	0.88
9M29	0.54	0.27	0.21	1.02	9M30	0.53	0.27	0.18	0.98
9F31	0.41	0.26	0.18	0.85	9F32	0.40	0.25	0.18	0.83
9F33	0.43	0.26	0.19	0.88	9F34	0.41	0.24	0.18	0.83
10F35	0.46	0.27	0.18	0.90	10F36	0.41	0.25	0.19	0.85
10F37	0.42	0.26	0.17	0.85	10F38	0.37	0.24	0.18	0.79
10F39	0.44	0.27	0.18	0.89	10F40	0.42	0.27	0.19	0.88
10M41	0.50	0.28	0.19	0.97	10M42	0.52	0.30	0.20	1.02
10M43	0.55	0.29	0.22	1.06	10M44	0.56	0.29	0.20	1.05
11M45	0.55	0.28	0.19	1.02	11M46	0.48	0.28	0.19	0.95
12M47	0.47	0.26	0.18	0.91	12M48	0.52	0.27	0.19	0.98
12F49	0.46	0.24	0.17	0.87	12F50	0.41	0.24	0.17	0.82
12F51	0.44	0.26	0.18	0.88	12F52	0.43	0.26	0.18	0.87
13F53	0.50	0.27	0.19	0.96	13F54	0.40	0.25	0.18	0.83
13M55	0.56	0.27	0.20	1.03	13M56	0.51	0.27	0.21	0.99
13M57	0.57	0.27	0.21	1.05	13M58	0.49	0.28	0.20	0.97
13M59	0.55	0.28	0.21	1.04	13M60	0.45	0.25	0.19	0.89

TABLE VIII. GROUP I

ANIMAL PAIR	DIFFERENCE IN AREA A (SQ. IN.)	DIFFERENCE IN AREA B (SQ. IN.)	DIFFERENCE IN AREA C (SQ. IN.)	DIFFERENCE TOTAL AREA (SQ. IN.)
1M1/2	0.02	0.02	0.02	0.06
1M3/4	–0.04	0.00	–0.01	–0.05
1M5/6	0.06	–0.01	0.00	0.05
1M7/8	0.01	0.00	0.00	0.01
2M9/10	0.02	–0.01	0.01	0.02
3F11/12	0.02	0.00	0.01	0.03
3F13/14	0.00	0.00	0.01	0.01
4M15/16	0.05	0.03	0.01	0.09
4F17/18	0.02	–0.01	0.00	0.01
5F19/20	0.02	0.00	–0.01	0.01
5F21/22	0.07	0.03	0.01	0.11
6M23/24	0.04	0.01	0.01	0.06
7M25/26	0.03	–0.01	0.00	0.02
8F27/28	0.02	–0.01	0.00	0.01
9M29/30	0.01	0.00	0.03	0.04
9F31/32	0.01	0.01	0.00	0.02
9F33/34	0.02	0.02	0.01	0.05
10F35/36	0.05	0.02	–0.01	0.06
10F37/38	0.05	0.02	–0.01	0.06
10F39/40	0.02	0.00	–0.01	0.01
10M41/42	–0.02	–0.02	–0.01	–0.05
10M43/44	–0.01	0.00	0.02	0.01
11M45/46	0.07	0.00	0.00	0.07
12M47/48	–0.05	–0.01	–0.01	–0.07
12F49/50	0.05	0.00	0.00	0.05
12F51/52	0.01	0.00	0.00	0.01
13F53/54	0.10	0.02	0.01	0.13
13M55/56	0.05	0.00	–0.01	0.04
13M57/58	0.08	–0.01	0.01	0.08
13M59/60	0.10	0.03	0.02	0.15

Minus sign indicates that the area of the soft diet mandible is greater than that of the hard diet mandible.

points of the mandible (Fig. 10). Consequently, this angle was measured and the data are presented in Table X. Except in two pairs, this angle was greater in the soft diet group than in the hard diet group. The mean difference between the two groups was 2.7 degrees, or 41 per cent.

TABLE IX. SUMMARY OF THE PLANIMETRIC STUDY. GROUP I

	HARD DIET ANIMALS	SOFT DIET ANIMALS	$\bar{d}$	PERCENTAGE d	t
Area A	0.492 sq. in.	0.462 sq. in.	0.030 sq. in.	6.5	4.62
Area B	0.268 sq. in.	0.264 sq. in.	0.004 sq. in.	1.5	1.60
Area C	0.192 sq. in.	0.188 sq. in.	0.004 sq. in.	2.1	1.50
Total area	0.951 sq. in.	0.911 sq. in.	0.040 sq. in.	4.4	4.20

g. *Width of the maxillae:* The width of the maxilla was measured between points on the buccal surfaces of the first molar teeth. These points were taken between the middle and distobuccal cusps (Fig. 11). It was found that the width

TABLE X. ANGLE FORMED BY THE OCCLUSAL PLANE AND A LINE DRAWN THROUGH THE MOST DEPENDENT POINTS OF THE MANDIBLE. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	ANGLE	ANIMAL NUMBER	ANGLE	d
1M1	10°	1M2	12°	2°
1M3	9°	1M4	9°	0°
1M5	7°	1M6	9°	2°
1M7	7°	1M8	10°	3°
2M9	6°	2M10	8°	2°
3F11	6°	3F12	7°	1°
3F13	6°	3F14	7°	1°
4M15	7°	4M16	8°	1°
4F17	6°	4F18	7°	1°
5F19	6°	5F20	8°	2°
5F21	6°	5F22	8°	2°
6M23	7°	6M24	8°	1°
7M25	6°	7M26	8°	2°
8F27	2°	8F28	10°	8°
9M29	7°	9M30	12°	5°
9F31	7°	9F32	11°	4°
9F33	9°	9F34	11°	2°
10F35	8°	10F36	9°	1°
10F37	5°	10F38	9°	4°
10F39	8°	10F40	9°	1°
10M41	7°	10M42	11°	4°
10M43	6°	10M44	10°	4°
11M45	6°	11M46	9°	3°
12M47	10°	12M48	9°	-1°
12F49	7°	12F50	12°	5°
12F51	7°	12F52	10°	3°
13F53	6°	13F54	8°	2°
13M55	6°	13M56	8°	2°
13M57	6°	13M58	12°	6°
13M59	3°	13M60	10°	7°
Mean	6.6°		9.3°	2.7°

of the maxilla of the hard diet group was 0.28 mm., or 3.2 per cent greater than the maxillary width of the soft diet group (Table XI). The *t* value for this difference was 5.79 and, therefore, this difference in width is significant.

TABLE XI. WIDTH OF THE MAXILLAE. GROUP I

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	WIDTH OF MAXILLA (IN MM.)	ANIMAL NUMBER	WIDTH OF MAXILLA (IN MM.)	d (IN MM.)
1M1	9.70	1M2	9.05	0.70
1M3	9.00	1M4	8.97	0.03
1M5	9.55	1M6	9.27	0.28
1M7	9.15	1M8	8.87	0.28
2M9	9.17	2M10	8.60	0.57
3F11	8.67	3F12	8.70	-0.03
3F13	9.00	3F14	8.62	0.38
4M15	9.50	4M16	8.92	0.58
4F17	8.60	4F18	8.40	1.20
5F19	8.65	5F20	8.60	0.05
5F21	8.80	5F22	8.42	0.38
6M23	8.72	6M24	9.02	-0.30
7M25	9.22	7M26	8.97	0.25
8F27	9.35	8F28	8.47	0.88
9M29	9.35	9M30	8.57	0.78
9F31	8.40	9F32	8.40	0.00
9F33	8.57	9F34	8.42	0.15
10F35	8.85	10F36	8.45	0.40
10F37	8.47	10F38	8.17	0.30
10F39	8.50	10F40	8.10	0.40
10M41	8.95	10M42	8.62	0.33
10M43	8.85	10M44	8.77	0.08
11M45	9.10	11M46	8.70	0.40
12M47	8.70	12M48	8.57	0.13
12F49	8.90	12F50	8.37	0.53
12F51	8.60	12F52	8.65	-0.05
13F53	8.85	13F54	8.62	0.23
13M55	8.95	13M56	8.77	0.18
13M57	9.30	13M58	9.02	0.28
13M59	8.87	13M60	8.75	0.12
Mean	8.95		8.67	0.28

2. *Group II Observations.—*

a. *Wear of the teeth:* The occlusal surfaces of the molar teeth of the hard diet group showed a marked degree of wear. This was most prominent on the first and second molar teeth which were, almost invariably, worn quite flat. The third molar teeth were not so obviously worn, the cusp height being reduced by about half.

The wear on the occlusal surfaces of the molar teeth of the soft diet group was of a moderate degree. This was most prominent on the first molar and least on the third molar. (Figs. 13 and 14.)

Macroscopic inspection of the dried mandibles revealed a difference between the two groups in the thickness of the articulating surfaces of the condyles. Although no measurement was made, the thickness of the articulating surfaces of the condyles of the hard diet mandibles was appreciably greater than that of the soft diet mandibles (Fig. 14). Therefore, by observing the amount of wear of the teeth and the thickness of the articulating surfaces of the condyles, it was possible to tell to which of the two groups each mandible belonged.

b. *Radiographic observations:* These findings were similar to Group I. The only difference between the two groups was in the density of the articulat-

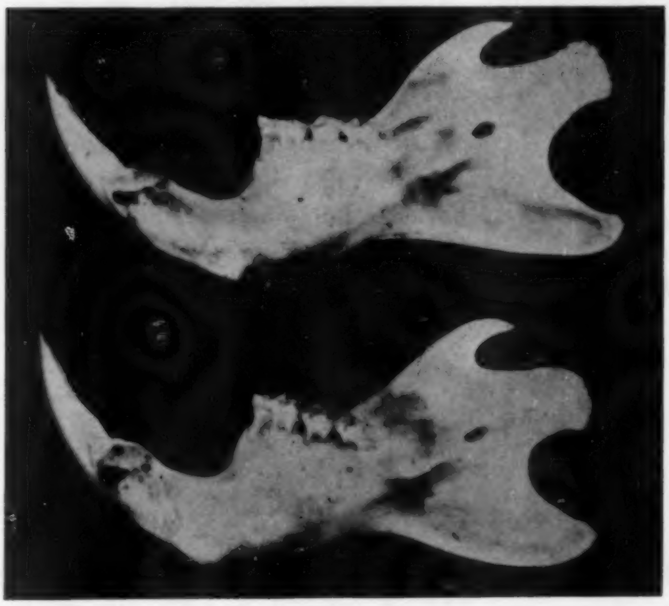

Fig. 13.—A lingual view of a pair of mandibles from Group II. In the hard diet mandible (top) the occlusal surfaces of the molar teeth are worn almost flat.

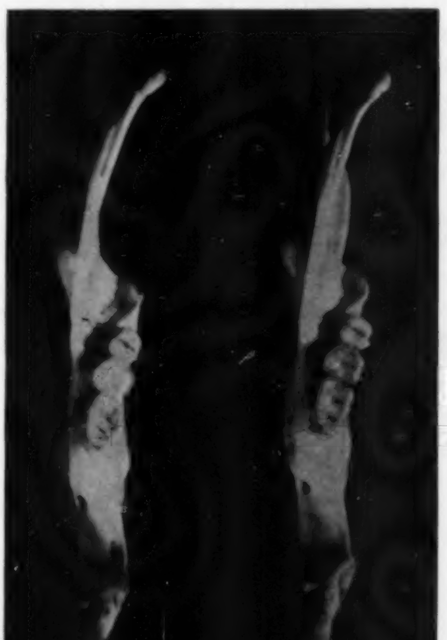

Fig. 14.—An occlusal view of the same pair as shown in Fig. 13. The hard diet mandible is at the left.

ing surfaces of the condyles. This surface was denser in the hard diet mandibles than in the soft diet mandibles. Apart from this no constant difference between the two groups in the density of the mandibles could be established.

c. *Weight, volume, and density of the mandibles:* Except in two cases, pairs A11/12 and A31/32, the hard diet mandibles were heavier than the soft diet mandibles. On the average, the hard diet mandible was 0.045 gram, or 9.12 per cent, heavier than the soft diet mandible (Tables XII and XIV). The t value was 5.55 and, therefore, the difference in the weights of the mandibles is a significant one.

TABLE XII. SUMMARY OF THE WEIGHT, VOLUME, AND DENSITY ANALYSIS. GROUP II

	HARD DIET ANIMALS	SOFT DIET ANIMALS	$\bar{d}$	PERCENTAGE d	t
Average weight	0.5385 gram	0.4935 gram	0.045 gram	9.12	5.55
Average volume	0.329 c.c.	0.303 c.c.	0.026 c.c.	8.58	5.00
Average density	1.635 gram/c.c.	1.627 gram/c.c.	0.008 gram/c.c.	0.05	0.73

In the volume data presented in Table XV, it will be observed that, with the exception of three pairs, A11/12, A25/26, and A31/32, the hard diet mandible was greater in bulk than the soft diet mandible. Therefore, in only two pairs, A11/12 and A31/32, was the weight and volume of the soft diet mandible greater than the hard diet mandible. The mean volume of the hard diet mandible was 0.026 c.c., or 8.58 per cent greater than the soft diet mandible. The t value was 5.00 and therefore the difference in volume is significant (Table XII).

TABLE XIII. BODY WEIGHTS OF THE ANIMALS AT THE BEGINNING AND END OF THE EXPERIMENT. GROUP II

HARD DIET GROUP			SOFT DIET GROUP		
ANIMAL NUMBER	INITIAL WEIGHT (IN GRAMS)	WEIGHT WHEN SACRIFICED (IN GRAMS)	ANIMAL NUMBER	INITIAL WEIGHT (IN GRAMS)	WEIGHT WHEN SACRIFICED (IN GRAMS)
A1	474	532	A2	495	534
3	446	502	4	452	450
5	430	486	6	410	504
7	410	492	8	400	484
9	454	500	10	462	554
11	400	468	12	410	478
13	488	542	14	500	556
15	450	488	16	420	478
17	424	488	18	420	480
19	398	438	20	410	446
21	458	486	22	476	556
23	430	450	24	472	472
25	415	458	26	424	500
27	400	442	28	432	480
29	390	416	30	400	456
31	370	430	32	420	460
33	440	444	34	474	552
35	410	480	36	380	456
39	490	560	40	456	484
Mean	430	479		437	494

TABLE XIV. WEIGHTS OF THE DRIED MANDIBLES. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	WEIGHT OF MANDIBLE (IN GRAMS)	ANIMAL NUMBER	WEIGHT OF MANDIBLE (IN GRAMS)	d (IN GRAMS)
A1	0.6010	A2	0.5248	0.076
3	0.5760	4	0.5212	0.055
5	0.5525	6	0.4589	0.094
7	0.5116	8	0.4490	0.063
9	0.5684	10	0.4880	0.030
11	0.5242	12	0.5458	-0.022
13	0.5800	14	0.5500	0.030
15	0.5442	16	0.4696	0.075
17	0.5103	18	0.4968	0.013
19	0.5226	20	0.4694	0.053
21	0.5788	22	0.5291	0.050
23	0.5287	24	0.4872	0.041
25	0.5092	26	0.5016	0.008
27	0.5008	28	0.4872	0.014
29	0.4898	30	0.4367	0.053
31	0.5058	32	0.5100	-0.004
33	0.5285	34	0.5029	0.026
35	0.5436	36	0.4258	0.118
39	0.5561	40	0.5228	0.033
Mean	0.5385		0.4935	0.045

Again it was observed that there was a marked similarity in the weight and volume data. Almost without exception, when the mandible was heavy, it was large, and when it was light, it was correspondingly small. By dividing weight by volume the average density of the mandible was obtained and it was found to be very constant for all the mandibles in both groups (Table XVI). The average difference amounted to 0.008 gram/c.c., or 0.05 per cent (Table XII). Statistically, this difference is not significant, the t value being 0.73.

TABLE XV. VOLUMES OF THE MANDIBLES. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	VOLUME OF MANDIBLE (IN C.C.)	ANIMAL NUMBER	VOLUME OF MANDIBLE (IN C.C.)	d (IN C.C.)
A1	0.37	A2	0.31	0.06
3	0.36	4	0.31	0.05
5	0.33	6	0.28	0.05
7	0.31	8	0.28	0.03
9	0.36	10	0.30	0.06
11	0.31	12	0.33	-0.02
13	0.36	14	0.33	0.03
15	0.33	16	0.29	0.04
17	0.31	18	0.30	0.01
19	0.32	20	0.30	0.02
21	0.36	22	0.33	0.03
23	0.33	24	0.30	0.03
25	0.31	26	0.31	0.00
27	0.31	28	0.30	0.01
29	0.30	30	0.28	0.02
31	0.31	32	0.31	0.00
33	0.32	34	0.31	0.01
35	0.33	36	0.27	0.06
39	0.33	40	0.32	0.01
Mean	0.329		0.303	0.026

TABLE XVI. AVERAGE DENSITY OF THE MANDIBLES. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	DENSITY OF MANDIBLE (IN GRAMS/C.C.)	ANIMAL NUMBER	DENSITY OF MANDIBLE (IN GRAMS/C.C.)	d
A1	1.62	A2	1.69	–0.07
3	1.60	4	1.68	–0.08
5	1.67	6	1.64	0.03
7	1.65	8	1.60	0.05
9	1.58	10	1.63	–0.05
11	1.69	12	1.65	0.04
13	1.61	14	1.67	–0.06
15	1.65	16	1.62	0.03
17	1.65	18	1.66	–0.01
19	1.63	20	1.56	0.07
21	1.61	22	1.60	0.01
23	1.60	24	1.62	–0.02
25	1.64	26	1.62	0.02
27	1.61	28	1.62	–0.01
29	1.63	30	1.56	0.07
31	1.63	32	1.65	–0.02
33	1.65	34	1.63	0.02
35	1.65	36	1.58	0.07
39	1.69	40	1.63	0.06
Mean	1.635		1.627	0.008

d. *Thickness of the mandibles:* With the exception of one pair, A11/12, the total buccolingual thickness of the mandible of the hard diet animal was greater than that of the soft diet animal. The mean difference was 0.005 inch, or 4.85 per cent (Table XVII). The *t* value was 6.8, making this difference statistically significant.

e. *Planimetric analysis:* The three times enlargement of the radiograph of each mandible was divided into three areas, A, B, and C, in a similar manner to that described for Group I. Again there was a significant difference in area

TABLE XVII. THICKNESS OF THE MANDIBLES. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	THICKNESS OF MANDIBLE (IN INCHES)	ANIMAL NUMBER	THICKNESS OF MANDIBLE (IN INCHES)	d (IN INCHES)
A1	0.115	A2	0.109	0.006
3	0.112	4	0.105	0.007
5	0.107	6	0.101	0.006
7	0.107	8	0.106	0.001
9	0.113	10	0.105	0.008
11	0.105	12	0.108	–0.003
13	0.109	14	0.105	0.004
15	0.105	16	0.097	0.008
17	0.105	18	0.103	0.002
19	0.106	20	0.100	0.006
21	0.112	22	0.104	0.008
23	0.110	24	0.103	0.007
25	0.104	26	0.103	0.001
27	0.106	28	0.103	0.003
29	0.103	30	0.094	0.009
31	0.106	32	0.102	0.004
33	0.108	34	0.103	0.005
35	0.102	36	0.094	0.008
39	0.109	40	0.108	0.001
Mean	0.108		0.103	0.005

A which was greater in the hard diet group than in the soft diet group. On the average, area A of the hard diet mandible was 0.039 sq. in., or 6.8 per cent greater than area A of the soft diet mandible, and the *t* value for this difference

TABLE XVIII. SUMMARY OF THE PLANIMETRIC STUDY. GROUP II

	HARD DIET ANIMALS	SOFT DIET ANIMALS	$\bar{d}$	PERCENTAGE d	t
Area A	0.617 sq. in.	0.578 sq. in.	0.039 sq. in.	6.8	4.48
Area B	0.301 sq. in.	0.298 sq. in.	0.003 sq. in.	1.0	0.81
Area C	0.236 sq. in.	0.235 sq. in.	0.001 sq. in.	0.4	0.26
Total area	1.155 sq. in.	1.112 sq. in.	0.043 sq. in.	3.9	3.95

TABLE XIX. AREA ANALYSIS. GROUP II

HARD DIET GROUP					SOFT DIET GROUP				
ANIMAL NUMBER	AREA A (SQ. IN.)	AREA B (SQ. IN.)	AREA C (SQ. IN.)	TOTAL AREA (SQ. IN.)	ANIMAL NUMBER	AREA A (SQ. IN.)	AREA B (SQ. IN.)	AREA C (SQ. IN.)	TOTAL AREA (SQ. IN.)
A1	0.64	0.32	0.23	1.19	A2	0.63	0.29	0.20	1.12
3	0.64	0.33	0.23	1.20	4	0.65	0.30	0.23	1.18
5	0.64	0.29	0.24	1.17	6	0.55	0.31	0.22	1.08
7	0.60	0.27	0.23	1.10	8	0.53	0.28	0.25	1.06
9	0.65	0.32	0.28	1.25	10	0.60	0.30	0.25	1.15
11	0.61	0.30	0.21	1.12	12	0.58	0.31	0.23	1.12
13	0.65	0.30	0.24	1.19	14	0.65	0.31	0.26	1.22
15	0.62	0.30	0.23	1.15	16	0.52	0.29	0.23	1.04
17	0.60	0.27	0.25	1.12	18	0.55	0.29	0.24	1.08
19	0.60	0.32	0.23	1.15	20	0.56	0.31	0.24	1.11
21	0.65	0.31	0.28	1.24	22	0.59	0.31	0.26	1.16
23	0.59	0.31	0.21	1.11	24	0.53	0.30	0.23	1.06
25	0.61	0.30	0.25	1.16	26	0.56	0.30	0.25	1.11
27	0.57	0.29	0.21	1.07	28	0.58	0.29	0.22	1.09
29	0.59	0.30	0.25	1.14	30	0.57	0.31	0.24	1.12
31	0.58	0.27	0.23	1.08	32	0.62	0.26	0.23	1.11
33	0.65	0.31	0.24	1.20	34	0.62	0.30	0.25	1.17
35	0.62	0.30	0.22	1.14	36	0.52	0.28	0.20	1.00
39	0.62	0.31	0.23	1.16	40	0.59	0.32	0.24	1.15
Mean	0.617	0.301	0.236	1.155	Mean	0.578	0.298	0.235	1.112

TABLE XX. GROUP II

ANIMAL NUMBER	DIFF. IN AREA A	DIFF. IN AREA B	DIFF. IN AREA C	DIFF. IN TOTAL AREA
A 1/2	0.01	0.03	0.03	0.07
3/4	–0.01	0.03	0.00	0.02
5/6	0.09	–0.02	0.02	0.09
7/8	0.07	–0.01	–0.02	0.04
9/10	0.05	0.02	0.03	0.10
11/12	0.03	–0.01	–0.02	0.00
13/14	0.00	–0.01	–0.02	–0.03
15/16	0.10	0.01	0.00	0.11
17/18	0.05	–0.02	0.01	0.04
19/20	0.04	0.01	–0.01	0.04
21/22	0.06	0.00	0.02	0.08
23/24	0.06	0.01	–0.02	0.05
25/26	0.05	0.00	0.00	0.05
27/28	–0.01	0.00	–0.01	–0.02
29/30	0.02	–0.01	0.01	0.02
31/32	–0.04	0.01	0.00	–0.03
33/34	0.03	0.01	–0.01	0.03
35/36	0.10	0.02	0.02	0.14
39/40	0.03	–0.01	–0.01	0.01

– sign indicates that the area of the soft diet mandible is greater than that of the hard diet mandible.

TABLE XXI. ANGLE FORMED BY THE OCCLUSAL PLANE AND A LINE DRAWN THROUGH THE MOST DEPENDENT POINTS OF THE MANDIBLE. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	ANGLE	ANIMAL NUMBER	ANGLE	d
A1	12°	A2	11°	–1°
3	12°	4	8°	–4°
5	11°	6	12°	1°
7	12°	8	13°	1°
9	12°	10	12°	0°
11	10°	12	14°	4°
13	11°	14	14°	3°
15	9°	16	13°	4°
17	11°	18	10°	–1°
19	14°	20	11°	–3°
21	12°	22	10°	–2°
23	12°	24	12°	0°
25	9°	26	10°	1°
27	10°	28	13°	3°
29	11°	30	11°	0°
31	12°	32	12°	0°
33	10°	34	8°	–2°
35	9°	36	10°	1°
39	14°	40	10°	–4°
Mean	11.2°		11.3°	0.1°

was 4.48. The difference in areas B and C between the two groups was insignificant, the t values being 0.81 and 0.26, respectively. Therefore, the area posterior to the molar teeth was greater in the hard diet group than in the soft diet group and there was no difference in the area of the remainder of the mandible (Tables XVIII, XIX, and XX).

f. *Angle formed by the occlusal plane and a line drawn through the most dependent points of the mandible:* The data pertaining to this angle are given in Table XXI. The mean value for the hard diet mandibles was 11.2 degrees

TABLE XXII. WIDTH OF THE MAXILLAE. GROUP II

HARD DIET GROUP		SOFT DIET GROUP		
ANIMAL NUMBER	WIDTH OF MAXILLA (IN MM.)	ANIMAL NUMBER	WIDTH OF MAXILLA (IN MM.)	d (IN MM.)
A1	10.49	A2	10.47	0.02
3	10.00	4	10.49	–0.49
5	10.03	6	10.37	–0.34
7	9.72	8	9.93	–0.21
9	10.67	10	10.01	0.66
11	10.24	12	10.18	0.06
13	10.05	14	10.23	–0.18
15	9.78	16	9.90	–0.12
17	9.76	18	9.91	–0.15
19	10.26	20	9.97	0.29
21	10.78	22	10.18	0.60
23	10.10	24	9.85	0.25
25	9.39	26	10.43	–1.04
27	9.91	28	10.32	–0.41
29	9.81	30	10.36	–0.55
31	9.88	32	9.80	0.08
33	10.38	34	10.31	0.07
35	9.96	36	10.20	–0.24
39	10.43	40	10.20	0.23
Mean	10.08		10.16	–0.08

– sign indicates that the area of the soft diet mandible is greater than that of the hard diet mandible.

and for the soft diet mandibles, 11.3 degrees. This difference of 0.1 degree is statistically insignificant, the t value being 0.18. It will be noted that this angle of approximately 11 degrees is appreciably larger than the mean angle of either the hard diet or the soft diet mandibles of the initial experiment.

g. *Width of maxillae:* The average width of the maxilla of the hard diet animals was found to be 0.08 mm., or 0.79 per cent less than the average width of the maxilla of the soft diet animals (Table XXII). This difference is statistically insignificant, the t value being 0.90.

DISCUSSION OF THE DATA

The observation of wear on the occlusal surfaces of the teeth under the influence of heavy function is an important one. Its significance has been emphasized by many writers, but there are a number of controversial opinions.[20, 38, 54, 60] Box[7] described the beneficial effects of occlusal wear on the development and health of the oral structures. He considers that wear of the teeth brings about an even distribution of function, a reduction in the steepness of the contacting surfaces which in turn may lead to an end-to-end occlusion of the anterior teeth. It is the opinion of Box that these changes are normal physiological processes in the aging of the dentition. Clearly, the difference in the degree of wear between the experimental groups must have been due to a difference in the physical consistency of the food, and it is suggested that the mastication of food that requires vigorous function is a factor of importance in this regard.

Occlusal wear in the rat is a continuous process and operates throughout the life of the animal.[44] According to the studies of Hoffman and Schour[21] on the rat molar, wear adjusts the extra-alveolar height so that it remains constant throughout life, while the length of the root increases by the continuous apposition of cementum. Thus, a good mechanical situation is created which is an important factor in the maintenance of periodontal health. But this mechanism does not necessarily operate in human teeth. The intra-alveolar lever arm is increased only very slightly by continuous apposition of cementum and, therefore, unless the extra-alveolar height is decreased in conjunction with wear, an unfavorable mechanical situation will result.

In both Groups I and II the radiographic evidence pertaining to the mandibles, with the exception of that of the condyle region, was negative. In thin, small bones such as the mandible of the rat, the radiograph is not a good method for showing small variations in bone density. According to the density analysis previously described, it is doubtful if any real difference existed. It has been shown that there was no significant difference in the average density between the hard and soft diet animals of Groups I and II, but it is conceivable that a difference might have existed in a specific area, for example, in the supporting bone about the molar teeth. However, in a histologic study of specimens taken from the Group I material,[52] no difference in the density of the supporting bone could be established. Therefore, it would appear that the change in masticatory function to which the mandibles of the rats were submitted produced no alteration in their density.

The analysis of the weight and volume of the mandibles is interesting. The mandibles of the animals that were given the hard diet in both groups were heavier and greater in bulk than those fed the soft, pappy diet, but yet their average density remained the same. It may be thought that the differences were only slight, but three factors must be considered:

1. The experiments were carried out for only a four-month period.
2. The difference in the degree of functional activity due to the alteration of the physical consistency of the food was not extreme. Most experimental observations have been made on the basis of heavy function as against a "loss of function."
3. The function of the incisor teeth of the soft diet groups was not interfered with. Normal wear of the incisors of these animals was obtained either by continuous grinding of incisor against incisor, or possibly by gnawing on the cages. This incisal function of the soft diet animals which caused wear of the teeth would have some effect on the growth and development of the mandible.

The real difference between the hard and soft diet groups was, however, apparently to be found in the functional load on the molar teeth and the associated muscular activity.

Brash[11] suggested that apart from internal structure, increase or diminution of use may affect any bone in three ways. He stated: ". . . the form of a bone might be altered; its size without alteration of form might be affected; and without a change in either the general form or size, the surface projections might be increased or diminished." The planimetric study tends to show that the form of the mandibles had been affected by a change in masticatory function. This was probably due to the increased activity of the muscles of mastication, because the area difference was confined to the region posterior to the molar teeth where the majority of the muscles are attached.

The similarity of the findings of both Groups I and II in respect to the weight, volume, and the area of the buccal aspect of the mandibles is striking. Changes in the size and form of the mandibles not only occurred in the young growing animals of Group I, but similar changes occurred in the adult animals of Group II. It is significant to note that the gain in total body weight of the Group II animals during the experimental period was small and there was no real difference in the body weights between the hard diet and the soft diet animals. Yet the mandibles of these adult animals that were fed the hard diet were heavier and greater in bulk than the soft diet adult mandibles. However, it must be realized that there is no evidence to suggest that the hard diet mandibles of Group II increased in size and bulk during the course of the study. It is conceivable that the soft diet mandibles may have atrophied or decreased in size while the size of the mandibles of the hard diet group may have remained the same. It is hoped that further evidence will be presented in the future to elucidate this point.

The difference in the thickness of the supporting bone is likely significant. Williams[60] maintained that an important predisposing cause of periodontal dis-

ease is frail development of the supporting structures. The evidence presented tends to substantiate the claim that the degree of masticatory function may be an important factor in this regard. This difference between the hard and soft diet mandibles is a constant finding except in one pair in each of Groups I and II, and must be due, in large measure, directly to a difference in the degree of masticatory load on the molar teeth as a result of the differences in the physical consistency of the food, since the measurement was made above the insertion of the masseter muscle.

The findings presented tend to differ from the findings of those who maintain that increased function will bring about a change in the density of a bone without an alteration of its form or size. Weinmann and Sicher[55] emphasized the importance of distinguishing between bones which are organs and bone which is a connective tissue. Bone tissue is biologically plastic and, as such, is capable of adaptation to the functional stresses acting upon it. It is likely that the outer form of a bone could be modified throughout life by the apposition and resorption of bone tissue. The experimental evidence presented in this report tends to support this opinion.

The change in the angulation of the occlusal plane is presented in this report as a matter of interest. No significance can be ascribed to it. The difference in this angle between the hard and soft diet animals of Group I might be attributed to the greater degree of occlusal wear of the hard diet specimens, resulting in a rotation of the occlusal plane so that it becomes more nearly horizontal. However, in the adult mandibles of Group II, there was not only no difference in this angle between the hard and soft diet groups but also the mean angle was appreciably larger than that of the Group I mandibles. Therefore, it would appear that the angulation of the occlusal plane does not necessarily depend on the degree of occlusal wear.

The data concerning the width of the maxilla are likely of significance. In the young growing animals of Group I vigorous masticatory function resulted in an increase in the width of the maxilla as measured between points on the buccal surfaces of the first molar teeth. But in the adult animals of Group II, the difference in the degree of masticatory function did not result in any change in maxillary width.

Transverse growth of the maxilla presents a complicated problem because the maxilla contacts all the bones of the facial skeleton except the vomer and the mandible. Weinmann and Sicher[56] described in detail the mechanism by which this growth takes place. Briefly, apposition of bone on the diverging pterygoid processes widens the interpterygoid space, allowing bone apposition to increase the posterior width of the maxilla. This increased width is translated forward by growth in the frontomaxillary, zygomaticomaxillary and the pterygopalatine sutures. Also, growth in the median palatine suture is a factor in the attainment of maxillary width. Therefore, this width depends mainly on sutural growth. The experimental evidence suggests that the mastication of foods that require vigorous function is likely an important stimulus in the growth in width of the maxilla in young animals, but in adult animals, after the growth sutures have fused, further increase in width is impossible.

While the inherent genetic factors concerned in the development of bones are extremely important, the influence that masticatory function has on the growth and development of the jaws appears to be of real significance. It is felt that the findings are important and significant to all those interested in dental health as affected by food intake. The importance of diet in relation to dental health is well recognized, but emphasis is usually placed on the nutritional or chemical constituents of food without due regard to its physical character.

SUMMARY AND CONCLUSION

The mandibles and maxillae of two groups of rats have been examined. Group I consisted of sixty young growing animals, thirty of which were fed a diet that required vigorous mastication, while the remainder were given a soft, pappy diet that required little mastication. Group II consisted of thirty-eight adult rats, half of which were given the hard diet and the remainder were fed the soft diet, these diets being the same as those supplied to Group I. The chemical composition of the hard diet was exactly the same as the soft diet, the only difference in the diets being in their physical character. The animals were fed experimentally for four months.

Findings in respect to thickness of the supporting bone about the first molar tooth, wear of the teeth, the weight, volume, density, and area of the buccal aspect of the mandible, and the width of the maxilla have been presented. The experimental evidence presented in this report tends to support an opinion that function, as influenced by differences in the physical consistency of food, is an important factor in the growth and development of the mandible and maxilla of the rat.

This study was planned and established with the assistance of the late Dr. F. F. Tisdall, Director of Nutritional Research, Hospital for Sick Children, Toronto, Ontario, Canada. It was conducted in the Department of Periodontology, Faculty of Dentistry, University of Toronto, and it was supported in part by a grant from the National Research Council of Canada. Dr. W. J. Linghorne, of the Banting and Best Medical Research Institute of the University of Toronto, had performed some preliminary trial studies which stimulated interest in the subject. Mr. D. B. W. Reid, of the School of Hygiene, University of Toronto, gave great assistance in the statistical analysis of the data.

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PHOTOGRAPHY AND CEPHALOMETRY IN DAILY ORTHODONTIC PRACTICE

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AT THE Northeastern Society Meeting in Washington, November, 1950, I had the opportunity of presenting a table clinic on "Kodachromes and the Cephalometer." There, I discovered that many men miss the advantages of using photography and cephalometrics in orthodontics because they are under the impression that it is too difficult, too complicated, and too much work. This paper endeavors to show how simple and important the use of photography and cephalometrics is, how easily both the camera and cephalometer can be used in one operating room, and how well both can be adapted to ordinary daily office routine.

Paul Simon was one of the first to emphasize the importance of the standardization of full-face photography. He insisted on the fixation of the camera and the subject so that he could duplicate his efforts three or six months later. This enabled him to record the actual changes in the face that took place during orthodontic treatment. B. E. Lischer and Frank A. Delabarre also pleaded for standardization and made valuable contributions along the same line. In that day the view type of camera was the one of choice. It called for ground-glass focusing and was a time-consuming technique.

Today, the use of the supplementary lens on the miniature camera has replaced ground-glass focusing to a great extent. This is a good thing, for it eliminates the fussing and fuming as well as the use of the old black hood which was so much a part of the earlier methods. Today, supplementary lenses provide a rapid means of obtaining accurate pictures. Speed inspires confidence, especially in the early stages of your relationship with your patient. In my opinion speed in photography is good psychology.

Additional advantages of the miniature camera are:

1. Compact size and easy adaptation to unit construction.
2. Simplicity, accepting black and white film as well as colored.
3. Economical in operation.
4. Camera can be removed from the unit for use in some other part of the hospital, or as a hobby.
5. Daylight loading.
6. Copy attachment can be added for extreme close-ups.
7. Also can be adapted for use with microscope.
8. Best camera for those inexperienced in photography.

This thesis was submitted to the American Board of Orthodontics in partial fulfillment of the author's requirements for certification.

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I should like to emphasize, however, that one cannot focus with a miniature camera closer than 3 feet from the subject. Something, therefore, must be devised to make the focusing automatic as one gets closer to the subject. This is accomplished by the use of a focal frame which has to be adjusted by an experienced photographer.

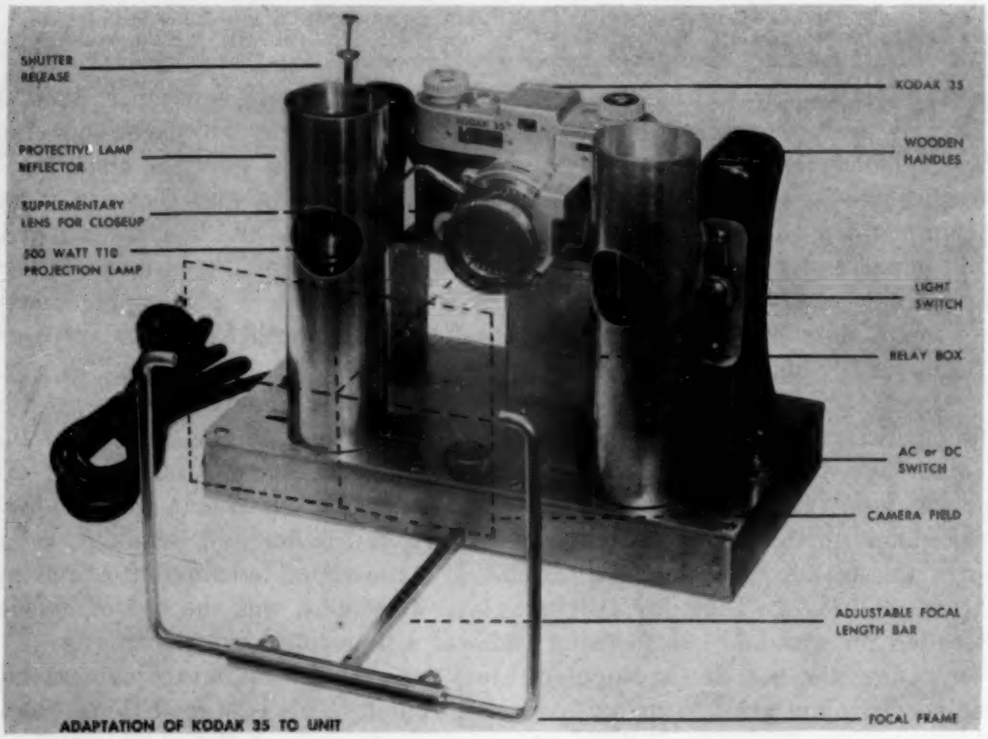


Fig. 1.—Adaptation of Kodak 35 to unit.

In the Department of Orthodontics* at the Evans Institute of Dentistry, University of Pennsylvania, we are now using a photographic unit which was designed for us by one of the senior students of the class of 1948. This uses the miniature camera to its greatest advantage (Fig. 1). The unit measures 11 by 6 by 9 inches and weighs about 6 pounds. Lights, camera, and focal frame are all mounted in one compact unit which is held in front of the patient's face (Fig. 2). This provides a rapid and economical means of obtaining accurate kodachromes or black and white pictures without wasting the patient's time. It reduces clinical photography to its simplest terms. Photographing the cast in occlusion is accomplished in the same manner.

No special photographic knowledge is necessary to operate the unit, for it is almost entirely automatic. Its results are standardized, consistent, and accurate. All one has to do is plug in the unit and make one adjustment of the lens opening. It photographs only the area desired and eliminates extraneous material from the picture.

*The Department is a unit of The Graduate School of Medicine.

The orthodontist is concerned with two types of pictures:

1. Close-ups of the mouth, known as intraoral photography.
2. Distant pictures of the face, known as full-face photography.

We shall now consider these in turn.

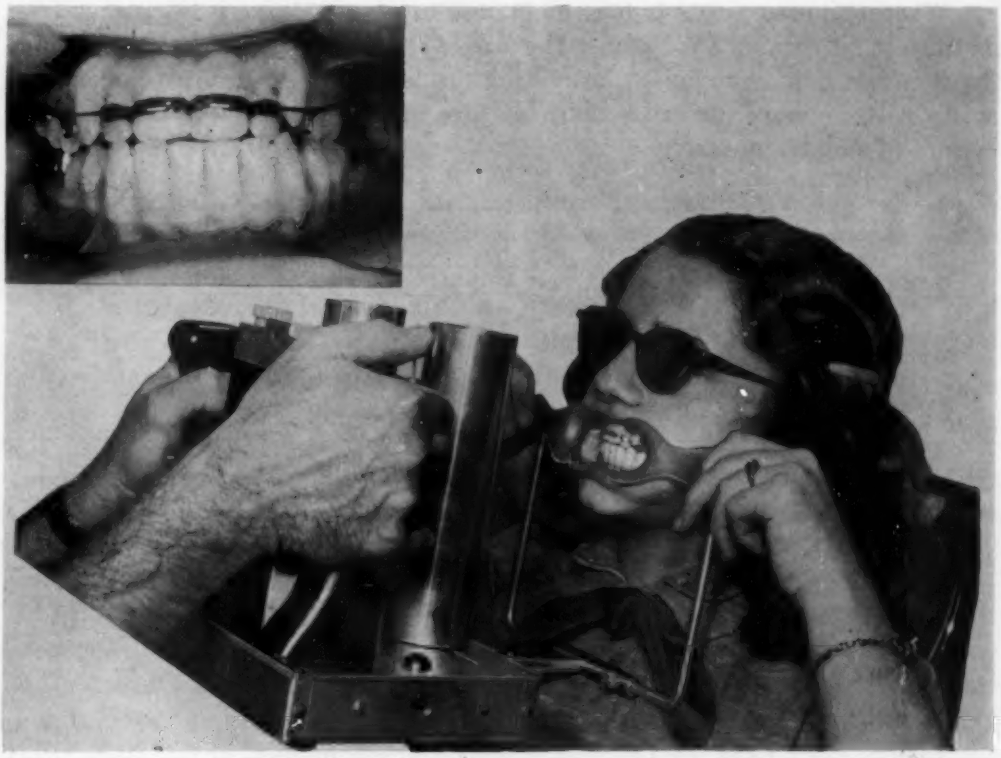


Fig. 2.—Taking intraoral pictures—front.

INTRAORAL PHOTOGRAPHY

As I have tried earlier to emphasize, the miniature camera can be focused only on close objects by the use of supplementary lenses. These lenses are known as Kodak Portra lenses. Their optical power is indicated by 1 plus, 2 plus, 3 plus, and up to 10 plus, the designation for 1, 2, 3, or 10 diopters, respectively. Nos. 1 to 3 are standard commercial supplementary lenses which can be purchased in the average camera store. Nos. 4 to 10, however, are especially ground high precision lenses and, if necessary, may be ordered from an optical company. Portra lenses can be used one in front of the other. Their powers are then additive. These lenses are adapted to the lens of the camera by virtue of a Kodak adapter ring and a Kodak retaining ring in the following order:

1. Kodak adapter ring, obtainable in many sizes
2. Kodak Portra lens 3 plus
3. Kodak retaining ring
4. Kodak Portra lens 2 plus
5. Kodak lens hood

This gives one a total power of 5 diopters which, in my experience, suits the needs of the orthodontist best. I have found that any higher powered addition results in a loss of depth of field. Any less will bring too much extraneous material into the picture. In other words, it is like fitting the camera with a proper pair of glasses.

When one uses a 5 plus lens he is able to get as close as 6¾ inches from his subject. From such a distance the size of the view is 3¼ inches by 5 inches. The depth of field is sufficient, providing the lens is stopped down far enough, i.e., to f. 16 or more, to get a sharp picture of the vault of the maxilla from incisors to molars, inclusive.

TABLE I. DEPTH OF FIELD (INCHES)

LENS	F/8			F/16		
	NEAR	FAR	TOTAL	NEAR	FAR	TOTAL
1 plus	1¾	2	3¾	2½	4¾	7
2 plus	¾	⅞	1⅝	1⅜	2⅛	3½
3 plus	⅜	⅝	1	¾	1¼	2
3 plus & 2 plus	⅛	¼	⅜	⅜	⅜	¾
10 plus	-	-	⅛	⅛	⅛	¼

TABLE II. SUBJECT DIMENSIONS

LENS COMBINATION	FOCUS SETTING (IN FEET)	WORKING DISTANCE* (IN INCHES)	CAMERA FIELD (IN INCHES)
1 plus	4	21⅝	10 by 15
2 plus	4	14	6½ by 9⅝
3 plus	4	10⅜	4¾ by 7⅛
3 plus & 2 plus	4	6¾	3¼ by 5
10 plus	4	3⅝	1⅝ by 2½

*Measured from front of ring insert to subject.

Just as the lens of a miniature camera will not operate at less than 3 feet, so the view finder will not operate at close range; hence, as I mentioned before, a device is necessary to frame what the camera eye sees and, also, to measure the working distance from the subject. Such a device is known as a "focal frame" (Fig. 1). This is merely a *U*-shaped aluminum rod attached to the unit by another adjustable aluminum bar in such a manner as to project the proper distance from the rim of the lens. This frame should be about 10 per cent larger than the field of view in order that it may not show in the picture. The *U*-rod should be so constructed that an imaginary line drawn horizontally across the top of the *U* will be the center of the picture horizontally. An imaginary line drawn vertically equidistant between the two upright arms will be the center of the picture vertically. At the point where these two imaginary lines cross lies an imaginary beam which, if extended 6¾ inches back, would reach the dead center of the lens (Fig. 1).

Several frames may be constructed, depending on the diopter power of the Portra lens selected. I find the 5 plus lens, along with its 6¾ inch focal frame, satisfies 90 per cent of the orthodontist's needs. Lights are 100 volt, 500 watt, T-10 prefocus base projection lamps (Bausch & Lomb or General Electric).

The following are essentials in taking the intraoral picture:

1. The patient's head should be supported by a headrest in a slightly tilted position in such a manner that an imaginary line passing along the lower border of the mandible parallels the floor.

2. The patient should wear dark glasses to protect the eyes from the glare of illumination (Fig. 2).

3. Place between the patient's lips a pair of plastic cheek retractors. Let the patient hold a retractor in each hand, between the index finger and the thumb, pulling the lips outward.

4. Set time at $\frac{1}{50}$ second for Kodachrome pictures.

5. Set lens distance at 4 feet for all pictures.

6. Lens opening should be adjusted to as small an aperture as possible to obtain the maximum depth of field.

7. Center object to be photographed in focal frame.

8. Turn on lights, wait a second to allow lamps to come to their proper color temperature. Flick shutter and turn film for next exposure.

FULL-FACE PHOTOGRAPHY

After the intraoral pictures are taken, the patient is prepared for the full-face pictures, profile and front-face. Since such pictures are distant ones, the camera can be conveniently attached to the fixator portion of a cephalometer in direct line with the x-ray beam.

In order to describe this more fully, a diagram of my own office layout is reproduced in Fig. 3. Note that it is not necessary to have special rooms, one for photography and one for cephalometrics. Both can be used to the best advantage in the same operating room with smoothness and efficiency. Note also that the x-ray transformer is in the standard position ordinarly used for general dentistry. The x-ray machine is now serving a dual purpose, namely, taking intraoral dental x-rays and cephalometric x-rays.

DESCRIPTION OF CAMERA SUPPORT

The procedure for taking both x-ray and Kodachrome pictures will now be described. A good profile x-ray picture should be taken 5 feet or more away from the subject, as should also a full-face camera picture. I have devised, therefore, a bayonet-shaped support for the camera which is attached to the x-ray fixator portion of the cephalometer (Fig. 4). This is used to maintain the camera in a fixed position for full-face photography after the x-ray picture has been taken.

In the dark room an 8 by 10 Blue Brand Eastman film is inserted into a cassette with double intensifying screens and the cassette is fitted in the film rack of the cephalostat. The patient is then seated in the chair for the head positioner of the cephalostat. The ear plugs are adjusted to fit snugly into the patient's external auditory meati, and the pencil-shaped metal pointer is placed on the left cheek at orbitale. The head is held securely in this position by a cup-shaped hard rubber disc on top of the head to which is attached an

adjustable metal rod (Fig. 5). At this time three x-ray pictures* are taken, the "freeway," the "open-bite," and the "centric," which are used for a Downs analysis. This technique will be described more in detail later.

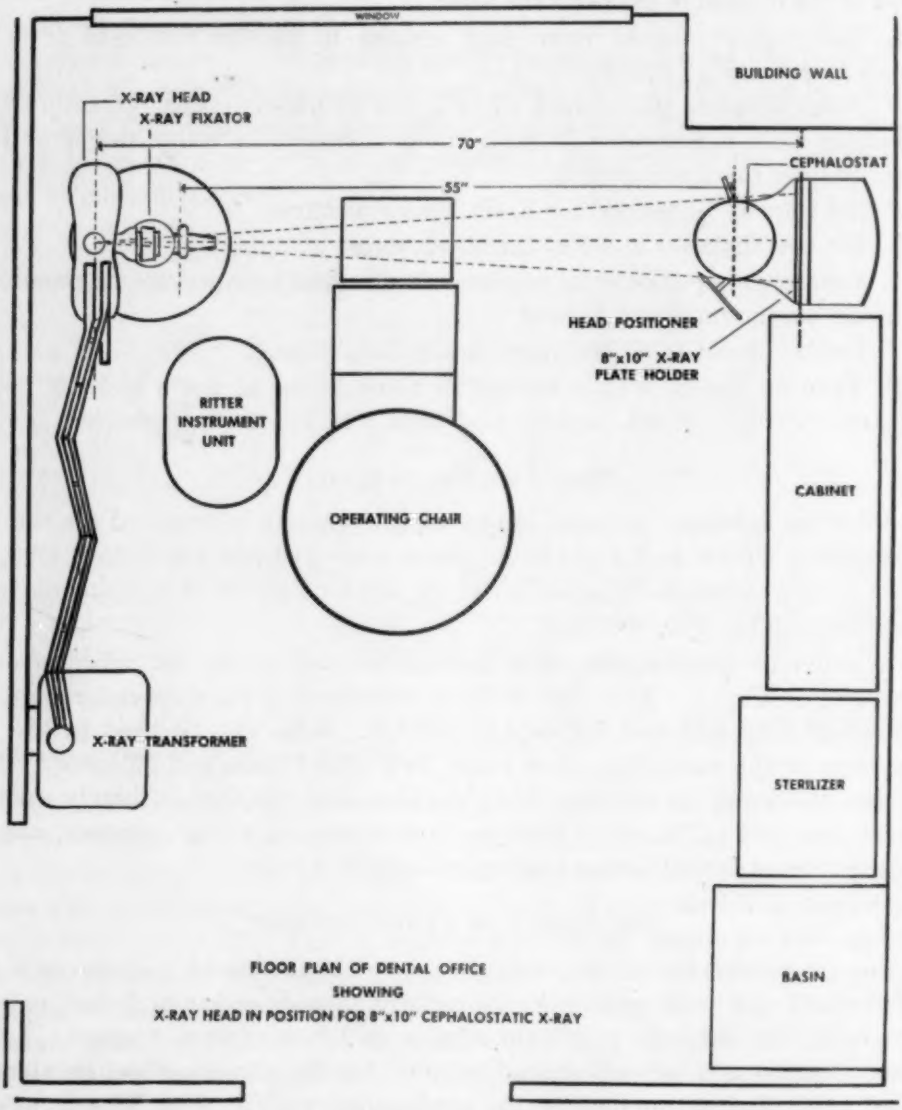


Fig. 3.—Floor plan of dental office.

The camera is now removed from the unit used for taking the intraoral pictures. The 35 mm. lens is replaced by a 90 mm. lens. The camera is then locked on the camera support of the x-ray fixator. The unit, without the camera, is placed on the instrument tray, approximately 3 feet from the sub-

*It is well to remember that in taking x-ray pictures protective measures against the harmful effects of overexposure to x-rays should be taken, not only for yourself but for those within range. All exposures should be made with the operator standing in back of a lead screen. It would be well to line the wall against which the cephalostat is mounted with lead paneling, especially if one is shooting the rays across the room as shown in the floor plan. This will protect a neighbor in the adjacent room.

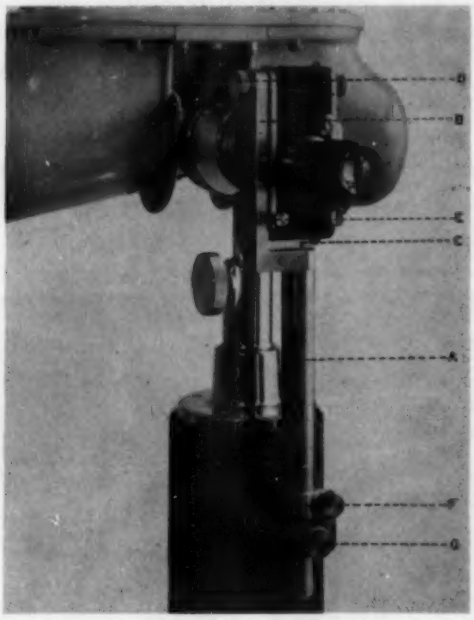


Fig. 4.—Bayonet type camera support. A. Support rod: Of 1 inch Duraluminum. B. Angle piece: Cut from solid piece of Duraluminum 2¼ inches by 1 inch by 6 inches. Upper part of bayonet-shaped angle piece measures 1 inch by ⅝ inch by 5½ inches (inside). Lower part of bayonet-shaped angle piece measures 1 inch by ⅝ inch by 1¾ inches (inside). C. Filister head screw with locking dowel pin. This holds together the support rod and the angle piece. D. Shoulder screw: Made of ⅞ inch Duraluminum, coursed and cut away to ⅝ inch and threaded to suit camera which is 20 threads per ¼ inch. E. Bridge piece: With two adjustable screws to steady camera in vertical position. F. Clamp: With adjustable screw for proper height. G. Rotation adjustment screw: ⅝ inch set screw.

Fig. 5.—Set-up for cephalostatic 8 by 10 x-ray and 35 mm. Kodachrome profiles.

ject to afford the necessary illumination for the picture (Fig. 5). In this position the exposure should be one-eighth second at f. 6.3 (Kodachrome film) or one-eighth second at f. 12.5 (black and white film). After the profile picture is taken (Fig. 6), the patient is requested to step from the chair. The head positioner and chair are then readjusted to face the camera. The patient is next seated in the chair in this new position looking directly into the lens of the camera (Fig. 7). The ear plugs and pointer are readjusted and a frontal view is photographed.

Fig. 6.—Cephalostatic profile.

Fig. 7.—Cephalostatic front face.

In taking full-face pictures, note two important essentials:

1. The picture must be true without any distortions of nose, cheek, or ears. There is an old adage often quoted by photographers, namely: "Never less than six feet, better, more than ten." In other words, do not get too close to your subject.
2. The procedure must be standardized so that it can be duplicated three or six months later in order to record the actual facial changes which have taken place during orthodontic treatment.

I have checked the accuracy of the camera when operating with the precision-like qualities of the cephalometer, in the following way. I have snapped a picture of a patient's head in the cephalostat in the manner previously described. The head positioner was then released and the patient stepped from the chair. Later she reseated herself, the head positioner was readjusted, and another picture taken. Then, after two films were processed, I superimposed one on top of another with perfect accuracy of facial lines.

Just as a standardized photograph is an extremely important aid to the orthodontist in daily practice, so the cephalometer alone can play a major role in routine appraisal and diagnosis. The late Dr. T. Wingate Todd was the first research worker to realize that it was more important to measure the head of a living child that is healthy than the head of a sick child. Thus, in cooperation with B. Holly Broadbent, D.D.S., the cephalometer was developed at Western Reserve University.* The benefit to the orthodontist is obvious. Here is a quantitative instrument particularly adapted to serial study of healthy growing children which locates precisely the bony landmarks, and thereby eliminates one of the chief difficulties of locating these landmarks through soft tissue.

Up to this point the thesis has considered techniques, per se. I would not be fulfilling the complete purpose of my study were I not to discuss cephalometrics at work, so to speak. Since I have stated that one headplate is taken for the Downs analysis of children with normal occlusion, therefore, I should like to present a short account of the use of cephalometrics in such an analysis. Parenthetically, cephalometrics is, of course, only one of several diagnostic aids (models, dental x-rays, growth studies, etc.) which are at the disposal of the orthodontist. To return to cephalometrics, it is necessary first to define certain cephalometric measuring points and planes. In addition, I shall briefly outline two pattern groups: (a) skeletal pattern; (b) denture to skeletal pattern. I shall then consider a typical case (Class II, Division 1).

Nasion†: The frontonasal suture, or junction of frontal and nasal bones. This is seen in profile as an irregular notch. The nasal bone is considerably less dense roentgenographically than the frontal bone, making it relatively easy to locate the suture even when the notch is not apparent.

Sella turcica: Literally the "Turkish saddle." The center of the bony crypt occupied by the hypophysis cerebri. Roentgenographically, a very constant profile outline when seen in its lateral aspect.

Porion: This is a machine registration of the most superior point of the external auditory meatus, known as cephalometric porion, not necessarily corresponding to the anthropometric landmark in the skull proper, which is known as true porion.

Orbitale: The lowest point on the inferior bony margin of the left orbit, usually as viewed in the lateral headplate. Measuring point determined on subject by palpation.

Gnathion: The most everted point on the profile curvature of the symphysis of the mandible. It is located by bisecting the angle formed by the mandibular plane and the facial plane.

Pogonion: The most anterior point on the symphysis of the mandible.

Menton: The most inferior point on the cross section of the symphysis of the mandible, as seen in the lateral headplate.

*It is known as the Broadbent-Bolton roentgenographic cephalometer in recognition of the interest and support of Mr. Charles Bolton.

†These points were selected with midline structure in mind, based on lectures by Wendell Wylie and on the article by Downs (1948).

Gonion: Bisection of the angle formed by the junction of the posterior margin of the ramus and lower margin of the body of the mandible.

Anterior nasal spine: The spinous process of the maxilla forming the most anterior projection of the floor of the nasal cavity.

Posterior nasal spine: The spinous process formed by the midline posterior projection of the conjoined palatine bones of the hard palate.

Pterygopalatine fossa: An oval-shaped ("teardrop") radiolucency resulting from the fissure between the anterior margin of the pterygoid process of the sphenoid bone and the profile outline of the posterior surface of the maxilla.

Bolton point: The juncture of the outer plate of the occipital bone with the posterior margin of the occipital condyles. The condyles bound the foramen magnum laterally and the established measuring point approximates the center of the foramen magnum, anteroposteriorly, when viewed in lateral headfilms.

Point A.: An arbitrary measuring point, viz., the point of maximum concavity at the junction of the base of the anterior nasal spine with the alveolar process of the maxilla, assumedly, the apical base, i.e., the approximate juncture of the basal or supporting maxillary bone and the alveolar bone. This point on the anterior profile outline of the maxilla is seen in lateral head films.

Point B.: An arbitrary measuring point, viz., the point of maximum concavity between pogonion and the labial alveolar crest as seen in the profile of the mandible. This most posterior point usually falls just anterior to the apices of the incisor teeth, and, like Point A in the maxilla, divides basal and alveolar bone.

Occlusal plane: A line drawn between points determined by the bisection of the overbite of the first molars and the central incisors. If this is obviously not a true occlusal plane, use the general plane of the molars and premolars.

Facial plane: Established by connecting nasion and pogonion.

Frankfort plane: Established on lateral head films by connecting the lowest point on the shadow of the left bony orbitale with the uppermost part of the ear-rod (porion).

Mandibular tangent: A line connecting menton with the lowest point in the angle of the left ramus. When the left and right mandibular rami are not precisely superimposed the distance between the lowest points on the angle of the two rami is bisected and a line is drawn to connect that point with menton.

"Y" (Growth) Axis: A line connecting sella with gnathion. The path of downward and forward growth of the face from beneath the cranium.

SKELETAL PATTERN*

1. *Facial angle:* Established by intersection of the facial plane (passing through nasion and pogonion) with Frankfort horizontal plane. Magnitude of angle increases with prominence of chin; tends to be smaller in Class II tendencies.

Minimal: 82.0° Average: 87.8° Maximal: 95.0°

*Adapted from Downs (1948).

2. *Mandibular plane angle:* Established by prolonging mandibular plane to intersect with Frankfort plane. This angle is large in unfavorable facial patterns.

Minimal: 17.0° Average: 21.9° Maximal: 28.0°

3. *Y (Growth) Axis:* Measured as the acute angle formed by the intersection of a line from sella to gnathion with the Frankfort plane. This angle is larger in Class II facial patterns than in those with Class III tendencies.

Minimal: 53° Average: 59.4° Maximal: 66°

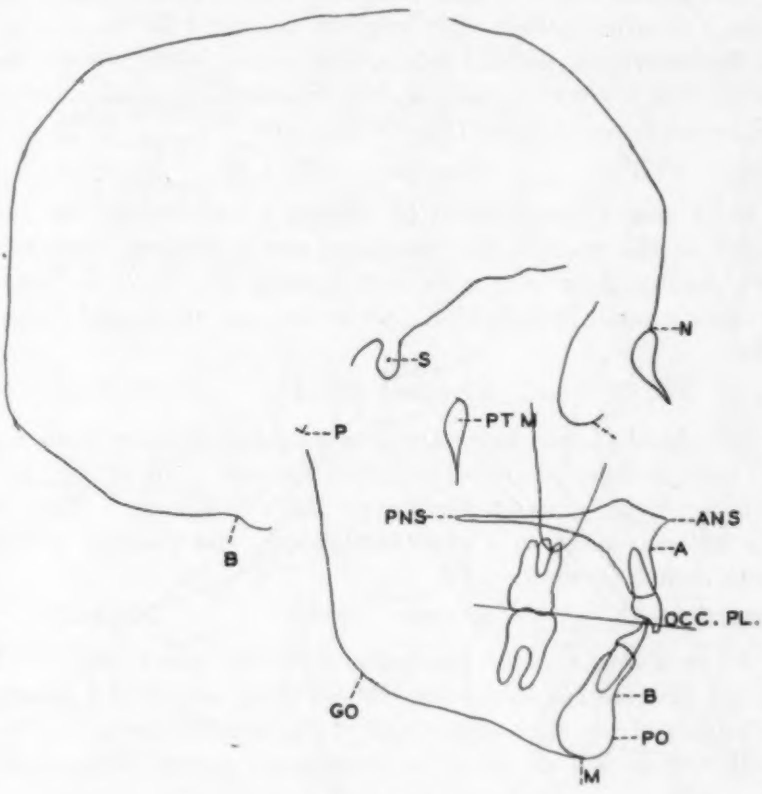


Fig. 8.—Points used in cephalometry.

4. *Angle of convexity:* A measure of the anteroposterior position of the maxillary alveolar base in relation to the rest of the profile. N and A and Po are connected with straight lines. Po-A is prolonged upward and forward (see Fig. 8) and the angle with the line N-A is read. This is a complement of N-A-Po to simplify records. If the extension of Po-A lies anterior to N-A the angle is positive. If the line Po-A when prolonged upward is posterior to N-A, the angle is negative. A negative angle of convexity is associated with a prognathic profile, large positive angles with relative prominence of the maxillary alveolar base.

Minimal: −8.5° Average: 0.0° Maximal: +10.0°

AB Plane—Facial plane angle: A measure of harmony in the anteroposterior positions of maxillary and mandibular alveolar bases. Points A and B (see definitions) are joined and extended, and the angle formed with the line

N-Po is read in much the same fashion as the previous determination. Since the point B nearly always lies behind point A, this angle is usually negative in value, except in Class III cases or in Class I's with definite prominence of the mandible. A large negative value suggests a Class II facial type.

Minimal: −9.0° Average: −4.6° Maximal: 0.0°

DENTURE TO SKELETAL PATTERN

1. *Cant of the occlusal plane:* Measures the slope of the occlusal plane to Frankfort, and is established by extending the occlusal plane posteriorly to intersect with the Frankfort plane. The angle is measured as was the mandibular plane with Frankfort. A parallel relationship would be 0.0°; when the anterior part of the plane is lower than the posterior, the angle is called positive. Larger positive angles are found in Class II facial patterns.

Minimal: +1.5° Average: +9.3° Maximal: +14.0°

2. $\underline{|1}$ *to* $\overline{|1}$ *angle:* Established by passing a line through the incisal edge and the apex of the root of the maxillary and mandibular central incisors, thereby establishing their long axes, and reading the angle so formed. This angle is relatively small in individuals whose incisors are tipped forward on the denture base.

Minimal: 130.0° Average: 135.4° Maximal: 150.0°

3. $\overline{|1}$ *to occlusal plane:* Intersection of long axis of lower incisor, as defined previously, with occlusal plane. The inferior inside angle is read as a plus or minus deviation from a right angle, i.e., the complement. This relates the mandibular anterior teeth to a functional plane, and positive values increase as these teeth incline forward.

Minimal: +3.5° Average: +14.5° Maximal: +20.0°

4. $\overline{|1}$ *to mandibular plane (incisor-mandibular plane angle):* The angle formed by the intersection of the mandibular plane with a line passing through the incisal edge and the apex of the root of the mandibular central incisor (see Fig. 9). This angle is positive when incisors are tipped forward on the denture base.

Minimal: +8.5° Average: +1.5° Maximal: +7.0°

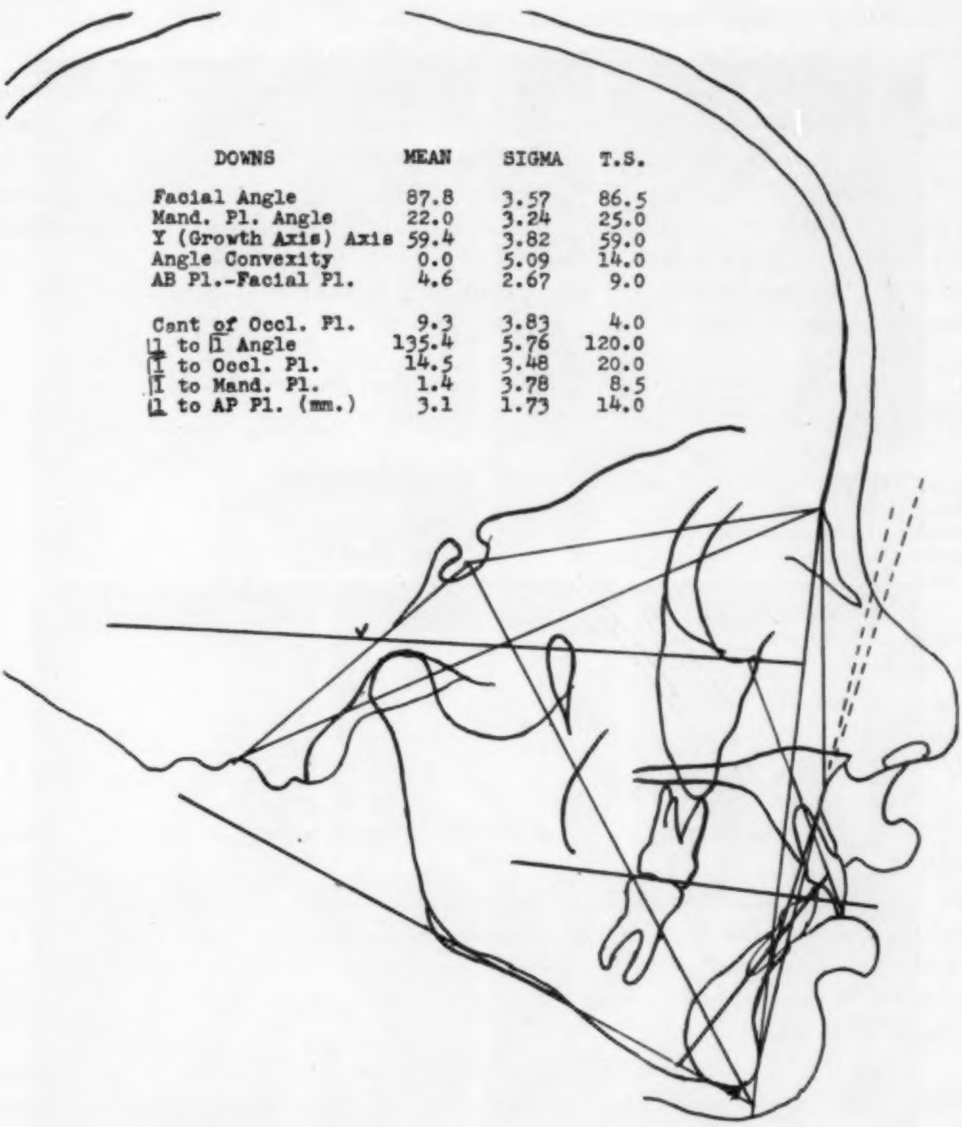
5. $\underline{|1}$ *to AP plane:* The distance in millimeters from the incisal edge of the maxillary central incisor to a line connecting point A with pogonion. The distance is positive unless the incisor lies behind the line A-Po.

Minimal: −1.0 mm. Average: +2.7 mm. Maximal: +5.0 mm.

APPRAISAL OF TYPICAL CASE (PATIENT T. S.)

Let us take for example a typical case of Class II, Division 1 malocclusion. How are we to know whether or not it will respond satisfactorily to treatment? If it is a mandibular displacement the time of treatment will be comparatively short and the retention possibilities excellent. If, however, it is a "true" Class II, then prognosis is not too favorable. Here, the use of cephalometrics is invaluable. Downs's "System of Analysis" not only enables

us to appraise the patient intelligently, but is also extremely useful in diagnosis. For this procedure two 8 by 10 x-ray films are used for each new patient, the first one to be of diagnostic value, the second solely for a Downs analysis.



DOWNS	MEAN	SIGMA	T.S.
Facial Angle	87.8	3.57	86.5
Mand. Pl. Angle	22.0	3.24	25.0
Y (Growth Axis) Axis	59.4	3.82	59.0
Angle Convexity	0.0	5.09	14.0
AB Pl.-Facial Pl.	4.6	2.67	9.0
Cant of Occl. Pl.	9.3	3.83	4.0
1 to 1 Angle	135.4	5.76	120.0
1 to Occl. Pl.	14.5	3.48	20.0
1 to Mand. Pl.	1.4	3.78	8.5
1 to AP Pl. (mm.)	3.1	1.73	14.0

Fig. 9.—Downs' analysis of tracing of Patient T. S.

The first 8 by 10 x-ray film records the mandible in rest position on one-half of the film while the other half is protected by a sheet of lead. The cassette is then reversed, the lead plate now protects the previous exposure, and the second picture is taken with the mouth wide open. We now have the "freeway" view and the "open-bite" view on one film. The second 8 by 10 x-ray film (Fig. 9) records the full-face profile in occlusion, and is known as

the "centric" view. We take advantage of the "open-bite" view by tracing the mandible with its clear outline of the condyle and superimposing this on the tracing of the mandible in occlusion. One can now trace the head of the condyle in its true position without interference of the zygomatic process which ordinarily obscures its view. The "freeway" view is extremely useful in depicting normal mandibular closure. Abnormal mandibular closure will reveal a posterior or an anterior mandibular displacement.

In appraising the tracing of patient T. S. (Fig. 9), one of the first things we must consider is whether or not there is a mandibular displacement present. To determine this takes little time. Make a tracing of the "freeway" view and superimpose it on the "centric" tracing. I suggest the use of a red pencil to outline this tracing. As one will note we have no mandibular displacement here. Therefore, it is logical to assume that we cannot depend too much on the mandible coming forward to help us in treatment. We are, therefore, beginning to suspect that this case will be difficult.

Table III. Cephalometric Appraisal (Patient T. S.)

	PATIENT	DOWNS' VALUES		
		LOW	MEAN	HIGH
Facial angle	87	82	87.8	95
Angle of convexity	+14	-8.5	0.0	+10
AB plane to facial plane	-11.5	-9.0	-4.6	0.0
Mandibular plane	24	17	21.9	28
Y axis	59.0	53	59.4	66
Denture to Skeletal Pattern				
Cant of occlusal plane	-2	+1.5	+9.3	+14
Angle $\underline{\lvert 1}$ to $\overline{\lvert 1}$	123	130.0	135.4	150.5
Angle $\overline{\lvert 1}$ to occlusal plane	+32.5	+3.5	+14.5	+20
Angle $\overline{\lvert 1}$ to mandibular plane	+10	+8.5	+1.5	+7.0
$\underline{\lvert 1}$ to A-Po plane (mm.)	+9.5	-1 mm.	+2.7	+5

Comparing the patient to the Downs norms we realize that her skeletal pattern compares rather favorably with the Downs range with one exception, the angle of convexity which is four points over the maximum in the range. The reading at plus 14 indicates that the entire maxillary denture base is forward plus 4° in relation to the rest of the profile. The Y Growth Axis is near the average range but the mandibular plane angle of 24° is near the high range of Downs' studies.

When we consider the relationship of this patient's denture to her skeletal pattern we note that the upper angle $\underline{\lvert 1}$ to $\overline{\lvert 1}$ (123°) is small, 7° below minimum. This strongly suggests tipping forward of the incisors on the denture base. The lower incisor to the occlusal plane is 32.5°, 12,5° over the Downs maximum. The lower incisor to the mandibular plane is plus 10° or 3° more than the Downs maximum. This also indicates considerable tipping forward on the mandibular denture base. The maxillary incisors to the A-Po plane measures plus 9.5 mm. which is 4.5 mm. more than the Downs maximum. All in all this is a troublesome case and one which strongly suggests the elimination of tooth units.

After the x-rays were processed it took me no longer than twenty minutes to trace the master profile film, draw the lines, measure and record the angles, and obtain the valuable information included in the previous paragraphs. In my opinion this is a good dividend for the amount of time invested. Note, however, that we have been comparing this patient to a range of figures for children with normal occlusion.

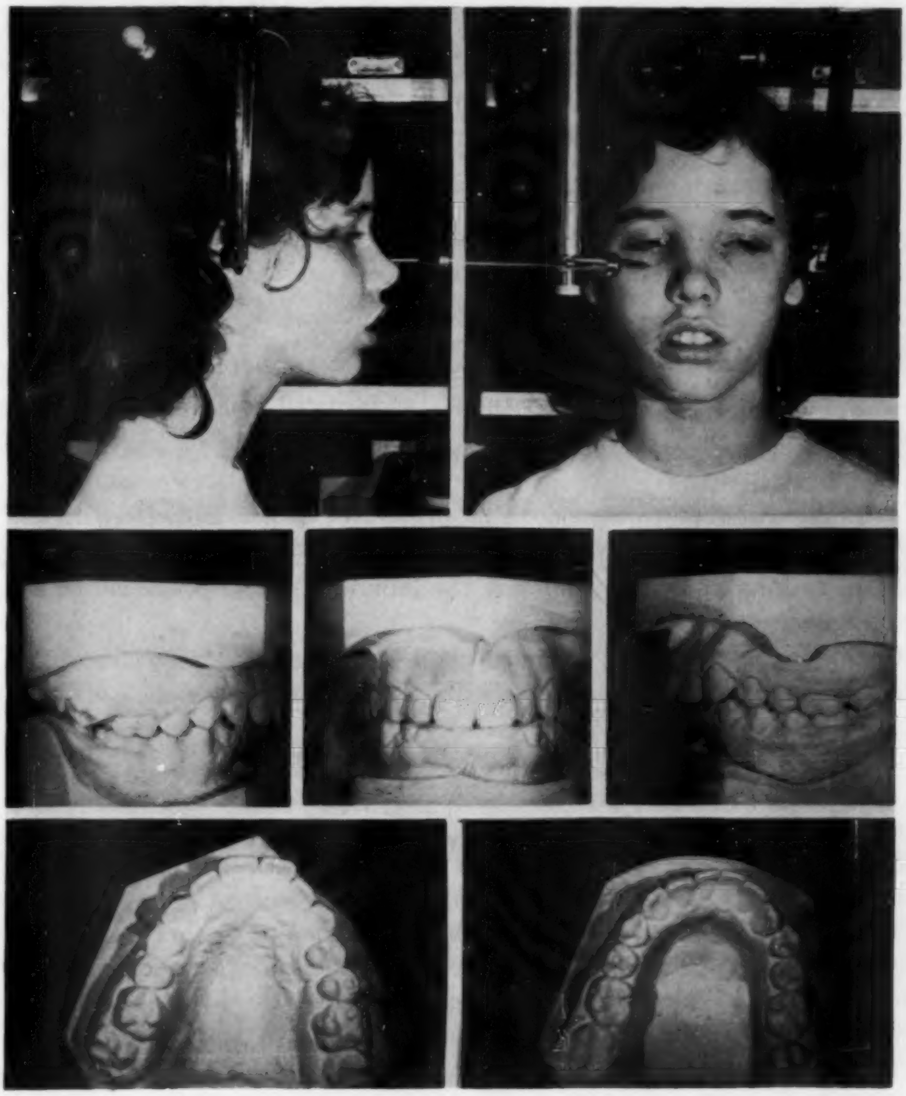


Fig. 10.—Photographs and casts of Patient T. S.

The cephalometer, just like any other instrument of science, must be used intelligently and wisely, remembering that its use must not be overextended. It will not show growth sites. It will, however, furnish an over-all accounting of growth. Moreover, we must also remember that we are dealing with a quantitative instrument that concerns itself with the measurement of mor-

phologic variations. Morphology cannot have rigid standards of normalcy because it has to do with the shape we are rather than the shape we are in. Note, therefore, that we have just compared Patient T. S. to a range of normal occlusions as Downs suggested. Using the figures in this way we obtain a lot of valuable information about her facial pattern which will give us a method of estimating the end result of her malocclusion.

SUMMARY

1. Orthodontists should be concerned with two types of photography:
   a. Close-up pictures of the mouth known as intraoral photography.
   b. Distant pictures of the face known as full-face photography.
2. The miniature camera is preferably the camera of choice:
   a. Its small size lends itself advantageously to unit construction for intraoral photography.
   b. Elimination of ground-glass focusing by the use of supplementary lenses makes it automatic and timesaving.
   c. Can be easily added to the cephalometer for full-face photography, thereby making these pictures standardized and directly comparable.

3. The cephalometer alone is a valuable instrument for daily use in the appraisal of patients.

4. Three x-ray pictures should be taken of all new patients: (a) "free-way" view; (b) "open-bite" view; (c) "centric" view.

5. In making appraisals compare the individual to a normal range and not a mean.

6. Do not use only the tracings as an aid to orthodontic treatment; use them in conjunction with model, dental films, growth studies, and so forth.

CONCLUSIONS

Photography and cephalometrics, in my opinion, are two of the most important aids to the orthodontist. It is surprising to me that they are not more widely used in daily practice. Many pictures taken by those who do use photography show nose, ear, and cheek distortion because there is a tendency to get too close to the subject. Attaching the camera to the cephalometer at its five-foot target spread not only avoids distortion, but, most important of all, it standardizes the pictures. Subsequent pictures taken three, six, or twelve months later will record actual changes in the face.

Many are still of the opinion that cephalometrics is an instrument of research and not easily adapted to office routine. Others feel that it involves too much expense and that the returns received do not warrant the investment. The floor plan shows how well and efficiently both can be used in one operating room. As to ultimate dividends, cephalometrics enables you to follow your patient as he marches along with time. The statics of a single observation (and its limited appraisal) no longer hamper or inhibit, but rather the dynamics of repeated assessment (with evaluation and judgment) capitalize upon functional

organic development. I am happy to go along with Downs as he says, "It is much more comforting to recognize your limitations before starting a case than to find out after months of treatment that you are not getting the nice results that other cases produce."

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MILITARY MEDICINE IN KOREA*

Major General George E. Armstrong, Surgeon General,
United States Army

TODAY, at a time when unification means to many of us a standardization of procedures or operations, joint staffing, interservice coordination, and many other aspects of the Department of Defense's over-all program, I would like to call attention to a special variety of unification.

I refer to the unity of effort within the services of the United Nations Forces in the Far East. Speaking personally, this was one factor which most impressed me during my recent tour of medical installations in Korea and Japan. Above and beyond this, it brought one point dramatically home, that the victories of military medicine which we have all noted in the Korean operation are not alone Army victories, nor even Army, Navy, and Air Force victories, but rather victories which can only be credited to the whole linked and magnificently effective United Nations medical team.

I would like to discuss the medical contributions of our allies in the United Nations briefly, because I think that they are all too easily overlooked by those of us not actually on the scene in Korea. This is due, in part, to our individual preoccupations with our own specific effort; in part, to the greater attention Americans necessarily give to their own forces; and to the fact that they are all individually relatively small units. I emphasize the word *individually* here, because I left Korea highly impressed with their collective weight, both qualitatively and quantitatively.

During my brief tour, I was able to see five of these units; each was extraordinarily well-staffed, highly effective, and standing high in the esteem of the American commander with which it worked. The units included the Swedish Red Cross Hospital at Pusan; the Norwegian Surgical Hospital, supporting one of our divisions, the British and Indian Field Ambulance Units, also supporting Eighth Army combat elements; and the Danish Hospital Ship, *Jutlandia.* All of these units have treated American patients and have won the gratitude of those for whom they cared. It is interesting to note that the *Jutlandia* has now left Korean waters to deliver patients of many United Nations countries to their homes. When she left, the Commander-in-Chief of the United Nations Forces, General Ridgway, personally bade her and her patients "Godspeed." Whether she returns or not, she will not soon be forgotten in Korea. Her volunteer staff represented the best in Danish medicine, and in the early days of the conflict the presence of one of the world's outstanding neurosurgeons aboard was a source of great comfort to us.

I regret that time does not permit me to give a more detailed analysis of the contribution of these units to the United Nations effort. The question is

*Address before the annual convention of the Association of Military Surgeons, Chicago, Ill.

sometimes raised as to whether our associates in the UN have adequately supported us in Korea. This is a diplomatic question, and certainly not one for an Army physician to comment on—either pro or con. But, if we were to move the question from the political sphere and ask instead whether there is evidence of spontaneous and sincere support for our position in intervening against North Korean and Chinese Communist aggression on the part of those peoples represented with us on the United Nations, the answer furnished by other United Nations troops, and more specifically, their medical units, is a rousing "Yes!" These units are volunteer units. The professional stature and outstanding qualifications of their staffs, coupled with the manner which they have performed, attest the reservoir of support they represent.

The Army is also indebted to the Medical Services of the Navy and Air Force for their contribution to the effectiveness of the Eighth Army in Korea. Early in the Korean campaign when American Forces were compressed into a tiny perimeter and both real estate and facilities were at a premium, the great floating hospitals which Navy hospital ships provided played an essential role in the care of our casualties. The hospital ships *Haven* and *Repose* were still in the Far East when I visited there. I was highly impressed with the fine professional work their staffs were doing. I was equally impressed with the excellent work being performed by the highly qualified staff of the Navy Laboratory Ship, based at Ko-je-do. In this connection, I must acknowledge a special debt of gratitude to our Navy colleagues for the 570 young Navy medical officers they loaned us early in the operation. Both as physicians and officers they were an exceptional group. The transition from Navy to Army customs and procedures was accomplished with unbelievably little difficulty, and they soon won the wholehearted plaudits of both Army line and medical officers with whom they served. Their return was accomplished conscientiously, but regretfully.

Our debt to our Air Force brethren is well known. The greater availability of air transportation has been responsible for several of the great advances in medical care which have taken place in Korea. Air evacuation of casualties and the ready availability of whole blood to Korean combat medical installations, made possible through speedy air express deliveries from the United States to Japan and from Japan to Korea, are two major evidences of inspired Air Force planning, which have resulted in steady improvements in effectiveness during the past year.

A special field in which the cooperation of all three services has been particularly noteworthy is the use of the helicopter for frontline evacuation. This type of evacuation, which in itself represents another advance in military medicine, has been possible because helicopters of all services have been made available on occasion for this type of mission, irrespective of the branch to which individual casualties might belong.

Against this background of unified effort, it might be well to consider just how well military medicine has done in Korea.

I think we will all agree that if we had the unhappy task of selecting a site for an American military operation, we would not select Korea. The

country has always been disease-ridden by occidental standards. Today the ravages of war have swept away even the inadequate safeguards present in normal times. The geography of the country, its high mountains and lack of roads, coupled with cold winters and hot summers, are additional impediments to combat operations. Finally, the seemingly inexhaustible flood of manpower available behind the Yalu River represents a continued problem from the standpoint of both strategy and tactics.

Despite these complicating factors, I have returned from Korea with complete assurance that we have done well; that we have, in fact, been far more successful than I believed was possible at the beginning of this operation.

Let us first consider those wounded in battle. In this field, there is only a limited role for preventive medicine, although we hope the wound ballistics and body armor studies we have just undertaken jointly with the Navy will offer some contribution. Broadly speaking, there is nothing we can do to reduce the number of those hit. We can only wait until the hits occur and evacuate the wounded to locations where they can receive proper treatment. However, in these two areas, evacuation and treatment, we have been highly successful. Here again I must remind you that I do not refer to the Army alone when I say "we," although my observations were naturally concerned primarily with Army units and my statistics, therefore, will be Army statistics.

At least one criterion as to the success of our work with the wounded is the number of those patients who live after reaching a medical aid station. I believe you all know that this number is currently only little less than double our experience in World War II, with only 25 of each thousand wounded dying, compared with 45 in the last war.

Behind this record are many contributing factors. One is the efficiency of the personnel who comprise our frontline medical service, basically, those who serve with combat battalions. I was particularly interested in medical care of this type and, consequently, spent much of my time in the Far East discussing it with our commanders, our patients and frontline troops. I can assure you that all of these people were proud of the physicians, Medical Service Corps officers, enlisted technicians, and aid men who provided the medical service for their units. I heard much about the high standard of professional "know-how" demonstrated by the young physicians serving as battalion surgeons. I observed the vital role played by Medical Service Corps officers in providing the essential background of field experience and the heroism of company aid men. All of them, commanders and troops alike, agreed that if it were humanly possible to "bring out" a wounded man, the company aid men and other medical personnel would do it, and that his subsequent evacuation and treatment would be fast and effective.

I believe these company aid men deserve a special word here, for I sometimes think we fail to recognize how much of the high regard our troops have for the Medical Service as a whole originates in the assurance they feel that the aid man attached to their platoon will see them through, even if he himself is wounded or killed in the process. I asked many soldiers who had just been wounded about their company aid men. They were eager to point out how

few moments had elapsed between the time they were hit and the time their own aid man had reached them. One man, whose evacuation had been slightly delayed, explained most apologetically that his "medic" had been killed just before he was wounded. The same pride was evident among commanders of all echelons. One corps commander complained that the aid men persisted in taking too many chances in order to get their wounded back. All of them pointed out the large numbers of decorations for heroism which had been awarded to these men. In the 7th Infantry, the first Distinguished Service Cross went to a medical enlisted man; in the 65th Infantry, the first Silver Star.

I have already mentioned the importance of the helicopter in making possible the rapid evacuation of wounded. Unquestionably, it has been of special importance in Korea where the terrain would have resulted in many instances in an inordinate delay if conventional means had been used. With the helicopter, it is possible to evacuate routinely seriously wounded patients from clearing, collecting, and aid stations, and even on occasion, from the front lines, in advance of the battalion aid station. The significance of this in terms of reduction of shock and suffering can be appreciated best when the dispersing of many combat medical installations, dictated by both tactics and terrain, is understood. In one situation, for example, it required a three-hour haul to bring some wounded to the battalion aid station, a half-hour jeep ambulance ride to the collecting station, another half-hour ride to the clearing station, and a final half-hour haul to the mobile Army surgical hospital. The value of an auxiliary method which permits seriously wounded patients to avoid these long, tedious trips over almost impassable roads is self-evident.

I have also referred to blood as being an important factor in slashing the mortality rate for our wounded. Two things were especially impressive in this regard—one was the large amount of blood and blood plasma that was being used on our patients; the other, the ingenuity and resourcefulness used to get the blood as far forward as possible. I can assure you that the days saved in the life span of whole blood by its rapid transportation from the United States are used to good advantage in Korea. Whole blood is routinely available in ample quantities at our most advanced hospitals, the mobile Army surgical hospitals. On occasion, it may be available even farther forward. Here again the ubiquitous helicopter plays a special role in emergencies. I have seen these vehicles fly forward with whole blood to evacuate a critically wounded patient from a battalion aid station, wait for the transfusion to start, and then fly back to the mobile Army surgical hospital while the patient was being transfused.

Within the divisional areas, there is one more factor that has helped us mightily in providing exceptional medical service. That has been the wholehearted cooperation of field commanders. I have already referred to the pride which these commanders manifested in the work of their medical teams. Actually, my extensive interviews with both line officers and unit surgeons revealed a very interesting phenomenon. Combat commanders boasted of the effectiveness of their medical units and the fact that this was achieved with

minimum interference with the mission of the command. Their surgeons were equally enthusiastic in describing how readily medical recommendations were adopted and how their units were given top priorities for road movements and for replacements. With such teamwork it is little wonder that the results have been outstanding.

Cooperation, courage, and ingenuity would serve little purpose if our professional standards were not high in the Far East. Our reduced mortality rates testify to their superiority. I was deeply impressed with the high quality of medicine and surgery practiced throughout our entire evacuation chain. It was as clearly evident at the most advanced installations as in our great hospitals in Japan. In this judgment, I have the hearty acquiescence of our many professional consultants who have visited these areas since the outbreak of the current conflict. This record is more remarkable when the youthfulness of most of our medical officers in the Far East is taken into consideration. Many of those holding important posts in the various specialties, for example, had just completed residencies prior to their shipment to Japan or Korea. The steadily maturing quality of their work is due primarily to their own professional integrity, but contributing to it have been the high standards of our own postwar Professional Graduate Training Program and of other comparable programs, the helpful tutelage of the professional consultants on the staff of the Chief Surgeon of the United Nations Command, and the wholehearted assistance of the many civilian consultants who have made frequent visits to our Far Eastern installations.

Much of what I have said about battle wounds applies with equal force to the problem of battle and rear area injuries in Korea. As in the case of casualties from wounds, they have been numerous and mainly from causes not readily susceptible to control by military preventive medicine. Fortunately, however, as with our wounded, our treatment record has been good, both in terms of reduced mortality and increased returns to duty. Only one of each one hundred injuries originating in Korea has died; 84 per cent have been returned to duty in the FEC alone.

There has been one special category of battle injuries which has and continues to give us much concern. I refer to the problem of cold injuries. The winter fighting in Korea has taken place in the lowest temperatures under which any major American campaign has been waged. In addition, the desperate fighting last winter at the time of the Chinese Communist entry into the operation presented some special features which intensified the problem—the long retreats in the X Corps sector, the many times when enemy envelopments prevented the expeditious evacuation of wounded and pinned our troops in their foxholes for prolonged periods, and the frequent loss of individual equipment. Because of all these factors, despite an excellent troop training program, close supervision of preventive measures by everyone from squad leaders on up, and reasonably adequate equipment for normal cold weather operations, we had about 6,000 cold injury casualties last winter.

Here again, I believe we may be proud of our treatment record. Cold injury casualties received special attention at all stages of medical service.

Centers for their treatment were established at the Osaka Army Hospital in Japan and at Percy Jones Army Hospital in the United States. The consequence of the treatment regimen has been an extraordinarily low percentage of amputations and an extremely high percentage of returns to duty.

It is too early to be unduly optimistic, but I think we may expect a lowered incidence of cold injuries during the coming winter. Certainly, the tactical situation is far more stabilized and units much more experienced. These twin factors by themselves should make a considerable reduction possible. In addition, we have made some progress in the matter of improved protection. We should recognize, however, that fighting under the climatic and terrain conditions that mark Korean winters will inevitably result in some of these casualties, and, consequently, we must continue our efforts toward even more effective treatment methods.

Disease admissions represent possibly the best test of the effectiveness of a medical service, for with this group, and this group alone, can considerable be done in the field of prevention. Certainly Korea represents an exceptional testing ground for any preventive medicine program. With so many diseases which have practically vanished from this country, either endemic or epidemic there, with not only all the water, but even the very soil highly polluted because of agricultural methods and primitive standards of sanitation, we could hardly be blamed if we were apprehensive when the operation began. That we have been successful is due not only to the eternal vigilance of our medical officers and the effectiveness of their methods, but also to the discipline of our troops and the wholehearted cooperation of their leaders.

Let us consider a few of the indexes of this success. Most of the diseases which have traditionally represented major military problems have been either practically nonexistent or dramatically lower than previous experience. Despite widespread water pollution, for example, there has been little typhoid fever. The actual incidence has been identical with that reported for the entire Army throughout the World War II years, including the large numbers of troops stationed in the United States.

Diarrhea and dysentery offer another dramatic example. It is no exaggeration to say that conditions in Korea are ideal for the propagation of these diseases, yet, the actual incidence during the first year in Korea was less than half of the World War II experience in Italy and the Philippines and less than one-fourth of the World War II incidence in the China-Burma-India Theater.

The list could continue indefinitely. There has been little typhus and smallpox as indicated by prisoners of war. The incidence of common respiratory diseases in Korea for the first year was half that of troops back home in the United States during the World War II period. Pneumonia incidence was identical with that reported for troops in the United States during World War II years.

One disease deserves special mention. I refer to malaria which still constitutes a problem whenever we fight in an area where the Anopheles mosquito has free sway. It is unfortunate that the advances made in fighting this disease during the past half century or more have been in refinements rather than

minimum interference with the mission of the command. Their surgeons were equally enthusiastic in describing how readily medical recommendations were adopted and how their units were given top priorities for road movements and for replacements. With such teamwork it is little wonder that the results have been outstanding.

Cooperation, courage, and ingenuity would serve little purpose if our professional standards were not high in the Far East. Our reduced mortality rates testify to their superiority. I was deeply impressed with the high quality of medicine and surgery practiced throughout our entire evacuation chain. It was as clearly evident at the most advanced installations as in our great hospitals in Japan. In this judgment, I have the hearty acquiescence of our many professional consultants who have visited these areas since the outbreak of the current conflict. This record is more remarkable when the youthfulness of most of our medical officers in the Far East is taken into consideration. Many of those holding important posts in the various specialties, for example, had just completed residencies prior to their shipment to Japan or Korea. The steadily maturing quality of their work is due primarily to their own professional integrity, but contributing to it have been the high standards of our own postwar Professional Graduate Training Program and of other comparable programs, the helpful tutelage of the professional consultants on the staff of the Chief Surgeon of the United Nations Command, and the wholehearted assistance of the many civilian consultants who have made frequent visits to our Far Eastern installations.

Much of what I have said about battle wounds applies with equal force to the problem of battle and rear area injuries in Korea. As in the case of casualties from wounds, they have been numerous and mainly from causes not readily susceptible to control by military preventive medicine. Fortunately, however, as with our wounded, our treatment record has been good, both in terms of reduced mortality and increased returns to duty. Only one of each one hundred injuries originating in Korea has died; 84 per cent have been returned to duty in the FEC alone.

There has been one special category of battle injuries which has and continues to give us much concern. I refer to the problem of cold injuries. The winter fighting in Korea has taken place in the lowest temperatures under which any major American campaign has been waged. In addition, the desperate fighting last winter at the time of the Chinese Communist entry into the operation presented some special features which intensified the problem—the long retreats in the X Corps sector, the many times when enemy envelopments prevented the expeditious evacuation of wounded and pinned our troops in their foxholes for prolonged periods, and the frequent loss of individual equipment. Because of all these factors, despite an excellent troop training program, close supervision of preventive measures by everyone from squad leaders on up, and reasonably adequate equipment for normal cold weather operations, we had about 6,000 cold injury casualties last winter.

Here again, I believe we may be proud of our treatment record. Cold injury casualties received special attention at all stages of medical service.

Centers for their treatment were established at the Osaka Army Hospital in Japan and at Percy Jones Army Hospital in the United States. The consequence of the treatment regimen has been an extraordinarily low percentage of amputations and an extremely high percentage of returns to duty.

It is too early to be unduly optimistic, but I think we may expect a lowered incidence of cold injuries during the coming winter. Certainly, the tactical situation is far more stabilized and units much more experienced. These twin factors by themselves should make a considerable reduction possible. In addition, we have made some progress in the matter of improved protection. We should recognize, however, that fighting under the climatic and terrain conditions that mark Korean winters will inevitably result in some of these casualties, and, consequently, we must continue our efforts toward even more effective treatment methods.

Disease admissions represent possibly the best test of the effectiveness of a medical service, for with this group, and this group alone, can considerable be done in the field of prevention. Certainly Korea represents an exceptional testing ground for any preventive medicine program. With so many diseases which have practically vanished from this country, either endemic or epidemic there, with not only all the water, but even the very soil highly polluted because of agricultural methods and primitive standards of sanitation, we could hardly be blamed if we were apprehensive when the operation began. That we have been successful is due not only to the eternal vigilance of our medical officers and the effectiveness of their methods, but also to the discipline of our troops and the wholehearted cooperation of their leaders.

Let us consider a few of the indexes of this success. Most of the diseases which have traditionally represented major military problems have been either practically nonexistent or dramatically lower than previous experience. Despite widespread water pollution, for example, there has been little typhoid fever. The actual incidence has been identical with that reported for the entire Army throughout the World War II years, including the large numbers of troops stationed in the United States.

Diarrhea and dysentery offer another dramatic example. It is no exaggeration to say that conditions in Korea are ideal for the propagation of these diseases, yet, the actual incidence during the first year in Korea was less than half of the World War II experience in Italy and the Philippines and less than one-fourth of the World War II incidence in the China-Burma-India Theater.

The list could continue indefinitely. There has been little typhus and smallpox as indicated by prisoners of war. The incidence of common respiratory diseases in Korea for the first year was half that of troops back home in the United States during the World War II period. Pneumonia incidence was identical with that reported for troops in the United States during World War II years.

One disease deserves special mention. I refer to malaria which still constitutes a problem whenever we fight in an area where the Anopheles mosquito has free sway. It is unfortunate that the advances made in fighting this disease during the past half century or more have been in refinements rather than

new basic techniques. Today, as at the turn of the century, the only way we know to prevent malaria is by eliminating carriers and vectors. We have improved weapons, of course, in the newer insecticides and insect repellents, but in the hurly-burly of combat they can hardly be expected to achieve complete success. With chloroquine we have an improved suppressant which will effectively maintain a man fit for duty and free from the acute phase of the disease until he leaves the combat area. Again with chloroquine and other antimalarial drugs, we have an improved treatment regimen which will guarantee a malaria patient a minimum of illness and discomfort.

Consequently, as might be expected, the incidence of malaria has been and remains very low in Korea. The incidence during the first year, for example, was about one-fifth that of the Mediterranean Theater and the Philippine Islands during the same period. But, no suppressant, no matter how effective, will prevent the eventual appearance of acute malaria. Thus, as might be expected, with more and more Korean veterans returning to the United States, malaria cases are appearing here. Since the beginning of the year, we have had about 6,500 such cases admitted to our medical installations in the United States. Fortunately, the great mass of these cases respond rapidly, requiring an average treatment period of no greater than seven days. Fortunately, too, with the precautions the Public Health Service, local public health agencies, and our own services are taking there seems little likelihood that these cases will represent any great threat to the health of the civilian population.

Perhaps we may soon have a partial answer to this malarial problem if Primaquine bears out earlier promise. We still have no magic vaccination against malaria in sight, but in Primaquine we have hope of an actual cure for the disease, which it may be possible to administer effectively before the acute phase ever appears, thus serving much the same purpose.

Complacency is deadly in the practice of medicine, particularly military medicine, and I am certain that all of us recognize that much more needs to be done. I have mentioned briefly cold injuries and malaria, but I know that many of you could add scores of fields where continuing work is essential. Many serious medical problems are already the subject of intensive and continuing study by our research and development workers.

But we should never permit our impatience with present medical weapons and our hopes for future advances to detract from the truly magnificent record that the medical personnel of many nations and all our military services have achieved in Korea.

Recently, I received a letter from General Matthew B. Ridgway in which he emphasized his own pride in this record. I would like to close with a portion of this letter:

"It has afforded me, first as Eighth Army Commander and later as Commander-in-Chief of the Far East Command, the greatest satisfaction to witness what the combination of selfless devotion to duty, professional skill and able administration can effect for the good of the personnel of many services and of many Nations. Unique among America's wars, the Korean conflict has seen

no epidemics on our side of any disease against which we have prophylactic defense (though the enemy has not escaped). The death rate in our hospitals is by far the lowest ever known in war. Our medical soldiers have gallantly and at the risk of their own lives, saved those of their armed comrades, being skillfully led by devoted medical officers. Our senior medical officers have never spared themselves, but have personally directed evacuation of our wounded under conditions fraught with extreme danger and difficulty."

Department of Orthodontic Abstracts and Reviews

Edited by

DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City

Physiological Tooth Migration and Its Significance for the Development of Occlusion. II. The Biogenesis of Accessional Dentition: By Louis J. Baume, *J. D. Res.* **29**: 331-337, June, 1950.

"The 'accessional dentition'* makes its appearance with the eruption of the first permanent molars which are guided into position by the distal surfaces of the second deciduous molars (terminal plane). When the distal surface of the mandibular molar is mesial to that of the maxillary, thereby forming a terminal plane with a mesial step, no adjusting mechanism is necessary to assure eruption of the first permanent molars into proper cuspal interdigitation (Fig. 1, *A*). If the terminal plane remains perpendicular, an end-to-end relationship of the first permanent molars may result (Fig. 1, *B*).

"Three theories have been proposed to explain the occlusal adjustment of the deciduous arches from the straight terminal plane into a mesial step:

"A. A mesial forward adjustment of the mandible in its fossa may occur during the period of the deciduous dentition. . . . If the mandible or the lower dental arch move forward, this must result in increased sagittal measurements between distal surface of the lower deciduous canine to the distal of the upper one. In order to determine whether such a movement takes place, this distance between the distal surfaces of the opposing deciduous canines was measured seriatim on plaster reproductions before and after eruption of the permanent first molars.

"B. The possibility of a forward migration of the lower teeth during the period of the deciduous dentition. . . . The observations made in the previous paper of this series showed that the terminal plane remained constant throughout the period of the deciduous dentition. It was therefore necessary to investigate whether such a change in the terminal plane takes place after eruption of the first permanent molars or not.

"C. A mesial tipping of the lower first permanent molars after shedding of the lower second deciduous molars may take place. . . . In order to demonstrate any probable movements of the posterior teeth in the upper or lower arches the distance from the distal of the second deciduous molar to the distal of the deciduous canine was measured before and after eruption of the permanent molars.

"A comparative study of casts of 60 cases before and after the eruption of the permanent molars revealed three distinct kinds of normal molar adjustment:

"1. In deciduous dentitions which terminated *with a marked mesial step* the first permanent molars erupted immediately into normal cuspal interdigita-

"*The transformation of the deciduous dentition into the mixed and the permanent dentitions has been divided into two processes: (1) the eruption of the 12 permanent molars, which were not preceded by deciduous teeth, is termed 'accessional dentition.' (2) The eruption of those permanent teeth which replaced the 20 deciduous teeth are the 'successional dentition.'"

"The above subdivision is justified on the basis of the histogenesis. While the 'accessional teeth' arise from the (deciduous) general dental lamina, the teeth of the 'successional dentition' develop from separate anlage laminae."

tion without altering the position of the neighboring teeth (Fig. 2, *A*). The occurrence of a mesial step at the end of a deciduous dentition was generally due to an increased mesiodistal measurement of the upper second deciduous molar over that of the lower. This, however, was found only in 8 cases (14 per cent). The messial axial inclination of the lower first molars as compared with the distal axia! inclination of the upper favored their normal occlusal relationship.

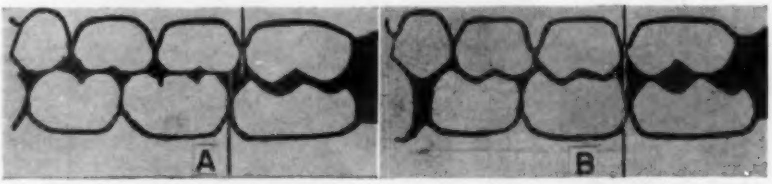
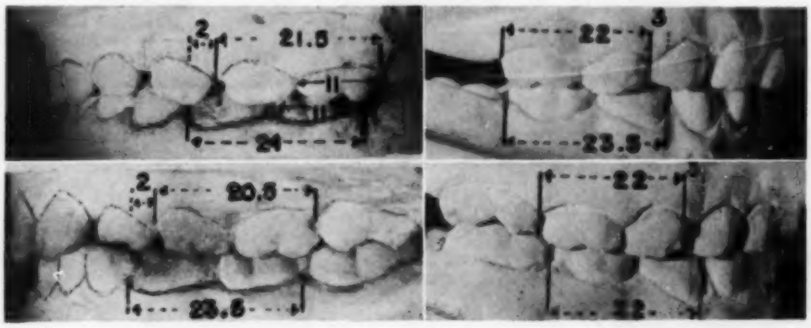


Fig. 1.—The development of occlusion of the first permanent molars.

A. Correct cuspal interdigitation behind a deciduous dentition in which the distal surfaces of the second deciduous molars form a mesial step.

B. End-to-end relationship behind a straight terminal plane of the deciduous dentition.



A. *B*.

Fig. 2.—Illustrations of two kinds of adjusting mechanisms which immediately produce proper molar occlusion.

A, Occlusion of the first permanent molars behind a *deciduous dentition terminating in a mesial step* is achieved directly. (The upper second deciduous molars show mesiodistally the same measurement as the lower.) (Case 11.)

B, Occlusion of the first permanent molar behind a *straight terminating deciduous dentition of Type I* is effected through mesial migration of the mandibular deciduous molars into the primate space (Case 33).

"2. In spaced deciduous dentitions of *Type I with a straight terminal plane* it was observed that following the eruption of the first permanent molars, the straight terminal plane had developed into a mesial step (Fig. 2, *B*). After the eruption of the first permanent molars, measurements of the distance between the distal surfaces of the second deciduous molars and the distal surface of the canines in the mandibular arches showed in all these cases a marked decrease of 1 to 2 mm. A simultaneous closure of the lower primate space was concomitant with this process. The deciduous molars had moved into the primate space. The extent of their mesial migration corresponded with the width of that space. Fig. 3 shows that the lower first permanent molar moves mesially after its eruption. It first contacts the second deciduous molar and then pushes the deciduous molars into the primate space.

"It is apparent that this mesial migration caused the change of the straight terminal plane into a mesial step since the corresponding maxillary distance remained unchanged. This process enabled the upper permanent molars to erupt directly into normal occlusion. Fig. 4 illustrates the progress of these changes in the same dentition of a patient between 5 and 7 years of age.

"Measurements between the distal surfaces of the opposing deciduous canines revealed that there was no change in that dimension in any of the 60 cases. . . .

"3. In closed dentitions of *Types II* a mesial migration of the lower deciduous molars cannot occur because of the absence of the primate spaces. The opposing permanent molars, therefore, are forced to erupt behind a straight terminal plane producing an end-to-end occlusion.

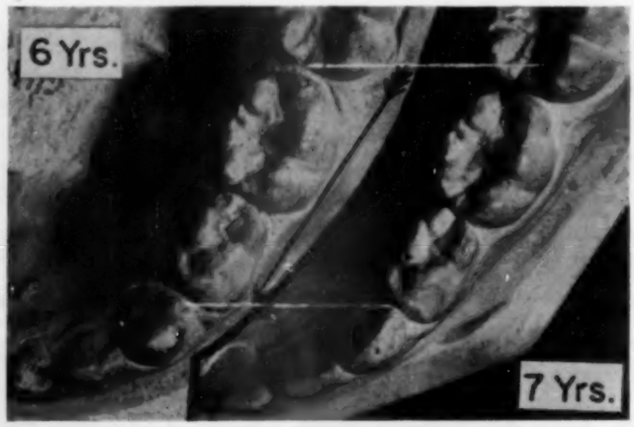


Fig. 3.—Biomechanism of physiologic mesial migration in Case 3. The lower first permanent molar has erupted at 6 years of age. Note a space between molar and second deciduous molar. This space and the primate space have disappeared one year later at 7 years of age.

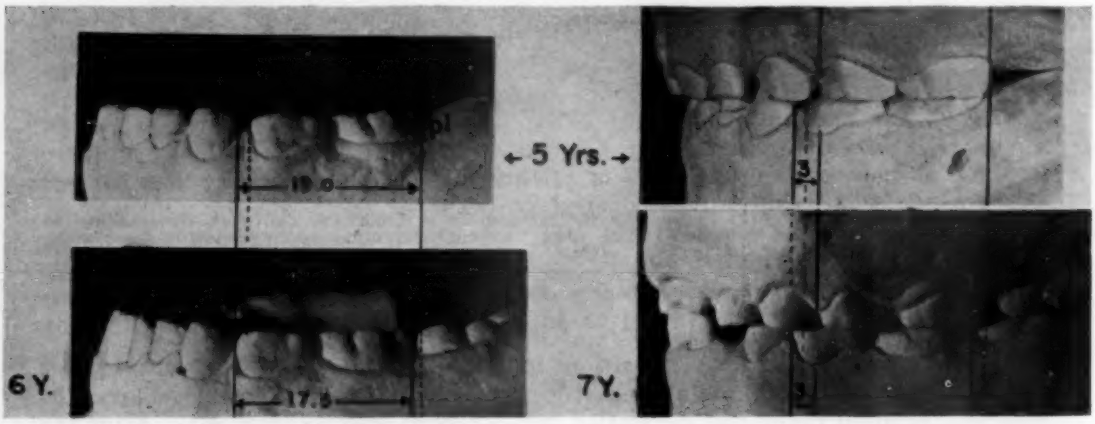


Fig. 4.—Occlusal adjustment of the first permanent molars in Case 60. Between 5 and 6 years of age the distance between the distal of the lower deciduous canine and the postlacteon (*pl*) decreased 1.5 mm. concomitantly with the closure of the mandibular primate space. The straight terminal plane at 5 years is transformed into a mesial step at 7 years, while the anteroposterior relationship of the deciduous canines remained unchanged. (Note closure of the maxillary primate space upon eruption of the upper central incisor.)

"It is a consistent observation that the permanent first molars move mesially whenever a space is created anteriorly due to loss of contact as the result of caries, extraction, or physiological shedding of a tooth. This indicates that a pressure in a mesial direction persists as long as the process of eruption of accessional teeth goes on. Since the mandibular premolars are narrower than their deciduous predecessors, some space is provided when the lower second deciduous molars are shed. The subsequent mesial migration of the lower permanent first molars change their end-to-end relationship into a normal one. This is the last adjusting mechanism of the permanent molar occlusion.

"Serial measurements in the maxilla between the distal of the second deciduous molars and distal of the canine revealed that an identical forward pressure also results in the closing of spaces whenever they existed. This is illustrated with models of Case 11 (Fig. 2, *A*) where a space between the upper deciduous canine and first deciduous molar was closed after eruption of the permanent molars. A pronounced mesial migration of the maxillary teeth, particularly when it is absent in the mandible, invariably produces malocclusion of the permanent molars, i.e., distoclusion.*

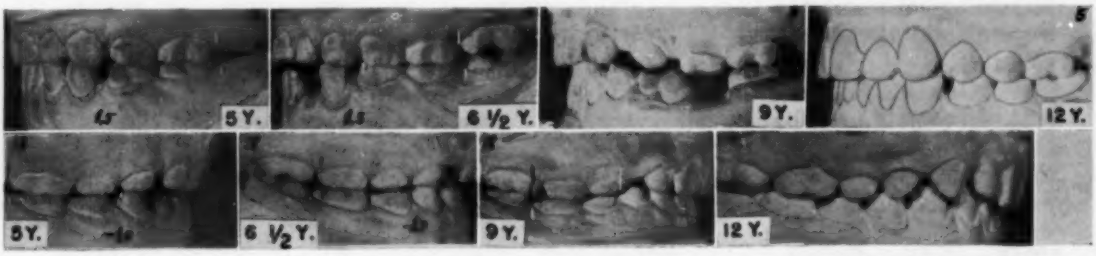


Fig. 5.—Transition of two deciduous dentures with end-to-end occlusion and marked abrasion *into distoclusion* after eruption of permanent molars. No change in the relationship of opposing deciduous canines took place.

A, Case 5. *B*, Case 18.

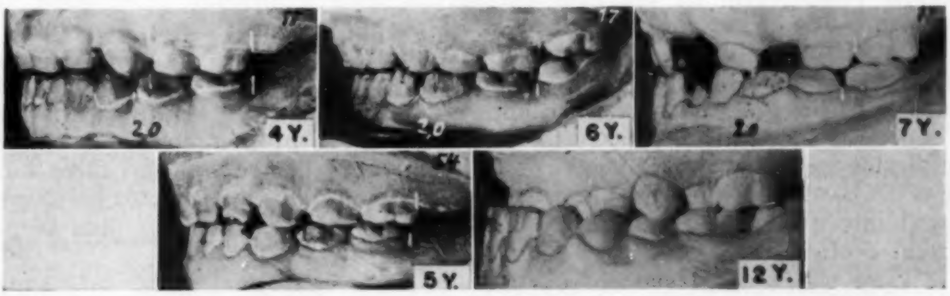


Fig. 6.—Transition of two deciduous dentures from *arthognathy* into *mesioclusion* after eruption of permanent molars. Note constancy of canine relationship.

A, Case 17. *B*, Case 54.

"The following analysis suggests that the etiological factors of the entire adjusting mechanism are mainly hereditary and endogenous; exogenous factors like function and attrition seem to be of comparatively little importance. The influence of forced mastication on the development of the dentition was studied on serial models for 9 cases with an end-to-end bite and marked cusp attrition of the deciduous molars and canines. Cases of this kind are supposed to produce ideal occlusion. Instead of developing into perfect dentures, malocclusion resulted in 7 of them. Four developed a distoclusion (Fig. 5) and 3 a mesioclusion (Fig. 6).

"Simultaneously, the unchanged relationship between the opposing deciduous canines revealed that the malocclusion was not the result of an anterior or posterior shift of the mandible. It was not surprising to note on other serial models that in spite of the absence of heavy attrition and the existence of a pronounced overbite, the permanent molars erupted into a perfectly normal occlusal relationship."

"*Angle Class II malocclusion also becomes fixed after eruption of the permanent molars behind deciduous dentitions with a terminal plane forming a distal stop. It was observed that here the upper permanent first molar always erupted before the lower one, which may be a helpful indication for the early recognition of this malocclusion."

"DISCUSSION"

"Measurements showing unchanged anteroposterior relationship of the opposing deciduous canines reveal that the concepts of a mesial shift of the entire mandible, or of the entire lower dental arch, are not borne out by facts. . . . Migration of the deciduous molars and not forward shift of the mandible constitutes a physiological measure by which proper occlusion of the permanent molars and mixed dentition is secured.

"The cause of the migration may be explained by the pressure exerted by the eruption and root formation of the permanent molars.* It constitutes a physiological regulator of the development of occlusion. The quality of occlusion depends on the extent of the forces and where and when they may become effective.

"On the basis of clinical studies three different mechanisms of normal occlusal adjustment have been described: (1) the direct occurrence of a mesial step, (2) the early mesial shift of the lower first permanent molar effecting a closure of primate spaces, and (3) the late mesial shift of the lower permanent molar subsequent to shedding of the deciduous molars. These mechanisms are interpreted as an expression of the law of variation which governs the course of every physiologic process. It is possible to have a combination of two or more of the processes occurring consecutively to produce occlusal relationship. The significance lies in the chronological order of their effectiveness.

"The first and second adjusting mechanisms secure immediately proper occlusal relationship of the first permanent molars directly after their full eruption. These are the surest forms of occlusal adjustment. They can be relied upon to maintain proper cuspal interdigitation even after the premature loss of the deciduous molars. The combination of the first and second mechanisms seems to be the uniform pattern in apes. The third is a typical human pattern. It expresses the effort necessary to ultimately attain proper molar occlusion in the phylogenetically reduced jaws of modern man. The second and third kinds are often combined when the closure of the primate space initiates an insufficient cuspal interdigitation of the first molars. The third mechanism thus secures normal occlusion.

"The widely held concept of the inhibition of normal molar adjustment by a severe incisal overbite could not be confirmed in this study. Serial observations revealed that deciduous dentitions with gliding articulation had the potentiality to produce poor molar occlusion while some dentures with deep overbite developed normal molar occlusion.

"The practical application of these findings to the problems of clinical orthodontia emphasizes the importance of changing an end-to-end occlusion of the first molars into their proper cuspal interdigitation as early as possible.

"A further clinical study of the development of occlusion in 60 children by means of serial plaster reproductions of the dental arches was made. Through comparative measurements, three different biologic mechanisms of normal occlusal adjustment of the accessional teeth were found:

. . . .

"1. The occurrence of a terminal plane forming a mesial step in the deciduous denture allowed the first permanent molars to erupt *directly* into proper occlusion without altering the position of the neighboring teeth.

"2. The presence of a mandibular primate space and a straight terminal plane was conducive to proper molar occlusion by means of an *early* mesial shift of the mandibular deciduous molars into the primate space upon eruption of the lower first permanent molar.

"*This early mesial migration is not to be mistaken for that minute one described by Weinmann and Sicher which they described as the result of the occlusal forces, and which is believed to be continuous."

"3. Closed deciduous arches and a straight terminal plane resulted in a transitory end-to-end relationship of the first permanent molars. Proper occlusion was effected through a *late mesial shift* of the mandibular permanent first molars subsequent to the shedding of the deciduous second molars.

"Migration of the lower deciduous and permanent molars constituted the physiological measure to secure proper occlusion of the permanent molars. There was no mesial shift of the mandible as indicated by the unchanged anteroposterior relationship of the opposing deciduous cuspids. Function and attrition had less bearing on the molar adjustment than widely assumed. The anatomical pattern of the deciduous arches controlled the ability of the deciduous and permanent molars to migrate mesially as a result of the eruptive force of the accessional teeth."

Orthodontie (Orthopédie Dento-Faciale): By G. Izard. Third edition revised and enlarged, with 1,272 figures. Masson & Cie, Editors. Libraires de L'Académie de Médecine, 120 Boulevard Saint-Germain, Paris, VI^e, 1950.

The third edition of Dr. Izard's book continues to remain the leading work in its field to be published outside of the United States. After having long been considered as a purely mechanical specialty, orthodontics is now more and more seen to be "based on biologic and medical science," states Izard, "although the mechanics are still important, since we have to resort to mechanics in treatment." It is for the foregoing reason that Izard devotes so much space in his important book to mechanotherapy in orthodontics.

In Part I of his book, Izard considers normal morphology and physiology including the biology of bone and general growth of the cranium and face. He presents a review of the work of Hellman, Broadbent, Margolis, and other American and European authors who have contributed to the knowledge of facial growth.

With respect to diagnosis, the author presents practical criteria. Cephalometrics are discussed in detail as are other diagnostic aids. Detailed information is presented on impression taking, roentgenographic examination, and the interpretation of cephalic roentgenograms. All types of orthodontic appliances, both European and American, are discussed and presented. The expansion plates are given consideration as are high labial appliances. The construction of bands is gone into in great detail, as are soldering and arch forming techniques. Many appliances devised at different times by various European and American authors are given due discussion, including Johnson, Mershon, and the Angle appliance.

Illustrations which are practically all in the form of line drawings are excellent and will prove of great interest and value even to the reader who is not acquainted with the French language in which this book is written.

Dr. Izard's book is a valuable asset in the library of every orthodontist regardless of the fact that he may not have a reading knowledge of French. There are sufficient illustrations presenting self-explanatory techniques to warrant the purchase of this book.

J. A. S.

News and Notes

The 1952 Meeting of the American Association of Orthodontists

The 1952 meeting of the American Association of Orthodontists will be held at the Jefferson Hotel, St. Louis, Mo., April 21 to April 24.

The chairman of the Local Arrangements Committee is Leo M. Shanley, 7800 Maryland Ave. The following local committees have been named to make the arrangements for the meeting:

	Local Arrangements	
Leo M. Shanley, Chairman	7800 Maryland Ave.	St. Louis, Mo.
E. V. Holestine, Treasurer	8015 Maryland Ave.	St. Louis, Mo.
Otto W. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.
George H. Herbert	7002 Pershing Ave.	St. Louis, Mo.
Benno E. Lischer	313 N. Rock Hill Road	Webster Groves, Mo.
Albert C. Mogler	462 N. Taylor Ave.	St. Louis, Mo.
H. C. Pollock	8015 Maryland Ave.	St. Louis, Mo.
Frank C. Rodgers	Missouri Theatre Bldg.	St. Louis, Mo.
Henry F. Westhoff	Missouri Theatre Bldg.	St. Louis, Mo.
Joseph H. Williams	3722 Washington Blvd.	St. Louis, Mo.
	Stag Dinner	
Joseph H. Williams, Chairman	3722 Washington Blvd.	St. Louis, Mo.
Robert E. Bedell	1504 S. Grand Ave.	St. Louis, Mo.
Carl L. Rister	University Club Bldg.	St. Louis, Mo.
George Herbert	7002 Pershing Ave.	St. Louis, Mo.
	Ladies' Entertainment	
Earl C. Bean, Chairman	120 N. Forsythe Blvd.	St. Louis, Mo.
Mrs. B. G. deVries	*Co-Chairmen*	
Mrs. H. C. Pollock	40 Fair Oaks	St. Louis, Mo.
Mrs. Otto W. Brandhorst	160 S. Gore Ave.	Webster Groves, Mo.
Mrs. Joseph H. Williams	24 S. Gore Ave.	Webster Groves, Mo.
Mrs. Leo M. Shanley	5 Glen Forest	St. Louis, Mo.
	Press	
H. F. Westhoff, Chairman	Missouri Theatre Bldg.	St. Louis, Mo.
H. C. Pollock	8015 Maryland Ave.	St. Louis, Mo.
	Banquet and Luncheons	
Virgil A. Kimmey, Chairman	3722 Washington Blvd.	St. Louis, Mo.
Robert E. Hennessy	8013 Maryland Ave.	St. Louis, Mo.
Robert C. Byrne	2602 S. Grand Ave.	St. Louis, Mo.
	Clinics	
Otto W. Brandhorst, Chairman	4952 Maryland Ave.	St. Louis, Mo.
Virgil A. Kimmey	3722 Washington Blvd.	St. Louis, Mo.
J. E. Rook	6651 Enright Ave.	St. Louis, Mo.
	Registration	
George Moore, Chairman	Box 8	Ann Arbor, Mich.
John Byrne, Co-Chairman	2602 S. Grand Ave.	St. Louis, Mo.
	Commercial Exhibits	
Earl E. Shepard, Chairman	4500 Olive St.	St. Louis, Mo.
William S. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.
Fred Fabric	4559 Scott Ave.	St. Louis, Mo.

Hosts

Leo B. Lundergan, Chairman	4500 Olive St.	St. Louis, Mo.
Robert M. Courtney	University Club Bldg.	St. Louis, Mo.
Kenneth C. Marshall	35 N. Central	St. Louis, Mo.
Quentin M. Ringenberg	3722 Washington Blvd.	St. Louis, Mo.

Property

A. C. Mogler, Chairman	462 N. Taylor	St. Louis, Mo.
Paul E. Spoeneman	16 Hampton Village Plaza	St. Louis, Mo.
E. W. Hodgson	Missouri Theatre Bldg.	St. Louis, Mo.

Reception

H. C. Pollock, Chairman	8015 Maryland Ave.	St. Louis, Mo.
Benno Lischer	313 N. Rock Hill Road	Webster Groves, Mo.
Frank C. Rodgers	Missouri Theatre Bldg.	St. Louis, Mo.
Joseph Williams	3722 Washington Blvd.	St. Louis, Mo.
Otto W. Brandhorst	4952 Maryland Ave.	St. Louis, Mo.

Hotel Reservations

J. E. Rook, Chairman	6651 Enright	St. Louis, Mo.
H. C. Pollock, Jr.	8015 Maryland Ave.	St. Louis, Mo.

Information

George Herbert, Chairman	7002 Pershing Ave.	St. Louis, Mo.
Clarence R. Geier	3417 Meramec Ave.	St. Louis, Mo.
Everett W. Bedell	1504 S. Grand	St. Louis, Mo.

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Hotel Jefferson, St. Louis, Mo., April 16 to April 20, 1952. Orthodontists who desire to be certified by the Board may obtain application blanks from the Secretary, Dr. C. Edward Martinek, 661 Fisher Bldg., Detroit 2, Mich. To be considered at the St. Louis meeting, all applications must be filed before March 1, 1952.

Prize Essay Contest, American Association of Orthodontists

Eligibility.—Any member of the American Association of Orthodontists; any person affiliated with a recognized institution in the field of dentistry as a teacher, researcher, undergraduate or graduate student shall be eligible to enter the competition.

Character of Essay.—Each essay submitted must represent an original investigation and contain some new significant material of value to the art or science of orthodontics.

Prize.—A cash prize of $500 is offered for the essay judged to be the winner. The committee, however, reserves the right to omit the award if in its judgment none of the entries is considered to be worthy. Honorable mention will be awarded to those authors taking second and third places. The first three papers will become the property of the American Association of Orthodontists and will be published. All other essays will be returned.

Specifications.—All essays must be typewritten on 8½ by 11 inch white paper, double-spaced with 1 inch margins, and composed in good English. Three copies of each paper, complete with illustrations, bibliography, tables, and charts must be submitted. The name and address of the author must not appear in the essay. For purposes of identification, the author's name, together with a brief biographical sketch which sets forth his or her dental and/or orthodontic training, present activity and status (practitioner, teacher, student, research worker, etc.), should be typed on a separate sheet of paper and enclosed in a sealed envelope. The envelope should carry the title of the essay.

Presentation.—The author of the winning essay will be invited to present it at the meeting of the American Association of Orthodontists to be held at St. Louis, Mo., April 21-24, 1952.

Final Submission Date.—No essay will be considered for this competition unless received in triplicate by the Chairman of the Research Committee on or before March 1, 1951.

J. A. Salzmann, Chairman, Research Committee,
American Association of Orthodontists,
654 Madison Ave.,
New York 21, N. Y.

Research Section Meeting of the American Association of Orthodontists

In accordance with the policy of recent years, time will be set aside for research reports at the coming meeting of the American Association of Orthodontists. Any individual desiring to report on a current research problem, completed or in progress, may do so by communicating with Dr. John R. Thompson, 311 East Chicago Ave., Chicago, Ill.

Each application should be accompanied by the author's name, address, and institution with which he works, if any. An abstract of not more than three hundred words should be forwarded at the same time. The abstracts must be in the hands of the committee not later than March 15, 1952.

Presentation time will be limited to ten minutes.

J. A. Salzmann, Chairman.

The Pacific Coast Society of Orthodontists

Northern Section

The Northern Section of the Pacific Coast Society of Orthodontists held its meeting on Aug. 24, 1951. The meeting was called to order by Arnold Stoller, Chairman. Richard Philbrick was named acting secretary in the absence of Fred Crutcher. Paul Lewis welcomed guests.

The meeting consisted of a most interesting round-table discussion. On the subject of "Occlusal Equilibration" panel consisted of Alton Moore, John Ingle, and John Wilfred Gallagher, all of the University of Washington, and A. C. Heimlich, of Santa Barbara, Calif.

Arnold announced that the next meeting will be on September 17 at the University of Washington, with Spencer Atkinson as guest speaker.

Paul Lewis has had correspondence with Dr. Clifford Whitman, of Hackensack, N. J., who has a marvelous paper on the treatment of children's habits from an orthodontist's viewpoint. Paul said that Dr. Whitman would be free to come out in February and hoped that some of the other sections of our Society would be interested in having him speak to them.

In attendance were: Haig S. Albarian, Fred J. Angle, George A. Barker, Carl F. Bruggeman, Arthur A. Fraser, William Gilmore, William E. Grenfell, O. E. Hartman, Howard Jan, Ernest L. Johnson, Roscoe L. Keedy, Howard M. Lang, Arthur B. Lewis, George R. McCulloch, Charles F. Mitchell, Morse R. Newcomb, John H. Parker, Robert D. Payne, John S. Rathbone, Arthur C. Rohde, John G. Ryan, William S. Smith, Cecil Steiner, Howard E. Strange, Walter J. Straub, Kenneth Terwilliger, E. W. Tucker, Fay C. Van, Kenneth M. Walley, Frederick T. West, Charles H. Tweed, E. Allen Bishop, Charles Craig, Gerald N. Dohner, D. H. Empenger, Emery J. Fraser, Kenneth S. Kahn, Paul D. Lewis, William P. McGovern, William Takano, Arnold Stoller, Richard Philbrick, Rudolph Gothenquist, Alton Moore, William Downs.

We met on September 17 at beautiful University of Washington Dental School overlooking blue Portage Bay.

We were most fortunate in having Spencer Atkinson as chief guest clinician. His pictures from his collection of nearly 1,200 skulls are the envy of everyone who has ever taken a photograph. He is able to impart a silky, ivory cast, and depth to the bone that actually enhance the detail to a greater degree than can be seen directly with the eye. His studies on the adolescent skull are probably unsurpassed in the world. His adult skulls, showing near perfect dentures in jaws which are at marked variance with our usually accepted ideas of normal, are most provocative. They indeed warrant sober reflection. We also received a gentle reminder never to drop our guard of awareness to leaning habits and muscular perversions.

Don MacEwan, through his membership in the Biological Photographic Society, presented a most remarkable movie (property of Veterans Administration) entitled "Intraoral and Pharyngeal Structures and Movements." The patient involved had lost a great deal of bone and soft structure on one side of the face from cancer, resulting in an unobstructed view of the tongue and other structures in action.

Central Section

The regular quarterly meeting was held at the Alexander Hamilton Hotel, San Francisco, Sept. 18, 1951, one week late to accommodate our speakers. This proved quite successful as a record of fifty-two were in attendance.

Members and guests present were: Members: R. M. Railsback, R. M. Curtner, Robert B. Murray, K. F. Terwilliger, Harry S. Thompson, Elgin Jackson, Susan Lindsay, Roy C. Cowden, Reuben L. Blake, G. H. Terwilliger, Seymore B. Gray, Art Corbett, Walter J. Straub, Thos. E. Lewis, Raymond E. Brownell, Peter Picard, Clu Carey, Cecil S. Rand, Glen Wm. Foor, Ben Ledyard, Jr., F. T. West, Ted Engdahl, George Hahn, James R. Seaman, C. W. Konigsberg, J. Kester Diment, Art Skaife, Ned H. Anderson, Ernest L. Johnson, Fred E. Havrilla, Lloyd M. Cox, Allen E. Scott, Carl O. Engstrom.

Guests: W. W. Paden, John E. Dumon, Jack R. Smithers, Wilfred Wong, Murry A. Bishop, Norman Wong, Ronald C. Light, Eugene E. West, Michael S. Zeradi, Kenneth Adamson, George Merchant, O. E. Hartman, L. H. Guy, William S. Parker, Donald E. Priewz, Alan R. Cass, Joseph B. Martinez, Robert F. Ramsey, Robert M. Elberg.

Ernest Johnson suggested from the floor that the Secretary be directed to contact Paul Lewis, of the Northern Section, in an effort to obtain Dr. Clifford K. Whitman to present his paper and clinic on "Habits" following his appearance in the north early next year; also send Dr. Whitman an invitation to appear before the Central Section, if it can be arranged.

Chairman Roy Cowden introduced our special guest, Kenneth Adamson, from Australia, who told the group how happy he was to be with us and, as there are only 16 orthodontists in his country, they long for discussion.

There being no further business, Chairman Roy Cowden turned the meeting over to Program Chairman Raymond Brownell, who introduced the first speaker of the evening, Glen Terwilliger, who discussed "Charles Tweed as a Personality," giving a history of his life and orthodontic career as related to the Tweed Seminar, and illustrated with slides. Following this, Program Chairman Ray Brownell introduced the second speaker of the evening, Glen Foor, of Richmond, Calif., who discussed "The Temporomandibular Joint and Its Relation to Orthodontic Treatment." Interesting slides of patients with anterior cross-bites treated with chin caps only, and of x-rays of the temporomandibular joints before and after treatment, put the finishing touches on an interesting, educational, and sociable meeting.

Southern Section

The regular quarterly meeting was held at the Nikabob Cafe, 875 South Western Ave., Los Angeles, Calif., on Friday, Sept. 14, 1951.

The meeting was called to order by Chairman John Hopkins at 2:30 P.M.

Program Chairman Robert Whitney introduced Drs. Steiner, Gawley, Muchnic, Paul, and Bruggeman, who presented a "Symposium on Extraoral Anchorage With Table Discussions."

A communication from Fred West was read regarding the selection of a meeting place for the A. A. O. in 1955.

It was moved by John R. McCoy that the Southern Section recommend San Francisco as the meeting place for the A. A. O. convention in 1955. Motion carried.

It was brought to the attention of the membership that there is a growing demand in this area by Negroes for orthodontic treatment. Very few orthodontists have indicated that they care to accept them as patients.

It was moved by Paul Husted that Fairman Fahrney act as chairman of a committee to call on Dr. McNulty, Dean of the School of Dentistry, University of Southern California, and request that they accept a Negro dentist for training in the orthodontic department of the Graduate School. Motion carried.

It was moved by Eugene Gould that a committee be appointed to arrange an orthodontic clinic for the next meeting of the Southern California State Dental Association in Los Angeles. Motion carried.

Harvey J. Cole, 220 South Catalina St., Redondo Beach, Calif., was unanimously approved for membership in the P. C. S. O.

Following the social hour and dinner, Robert Gawley introduced Francis M. Pottenger, Jr., M.D., who presented "A Three Space Study of the Head Using Three Basic Roentgenographs Taken at Right Angles to Each Other."

Southern Section members present were: W. M. Adams, E. W. Anderson, Carl Bruggeman, W. E. Crapo, Sydney Cross, M. B. Davis, C. F. S. Dillon, M. L. England, A. L. Everett, Eugene Farber, Fairman Fahrney, A. V. Fluhrer, R. J. Gawley, George Grasser, A. S. Gray, I. E. Gould, Albert C. Heimlich, J. B. Hopkins, P. R. Husted, E. M. Johnson, R. L. Keedy, H. M. Lang, J. R. McCoy, Fred McIntosh, T. S. Martin, F. D. Moodie, H. V. Muchnic, George Nagamoto, C. W. Neff, T. B. Paul, J. S. Rathbone, L. R. Sattler, Betty Selmer, Herbert Shannon, Cecil Steiner, C. E. Thompson, F. C. Van, R. L. Whitney, J. B. Wilson.

Guests: George Boone, E. A. Boyd, W. G. Brown, H. J. Cole, W. C. Dorsett, Jr., R. S. Hambleton, M. E. Hill, Jr., W. M. Jow, K. D. Raak, O. E. Ridgeway, Gene Springer, C. L. Vollmer.

Southwestern Society of Orthodontists

The thirty-first annual session of the Southwestern Society of Orthodontists was held Sunday, Monday, Tuesday, and Wednesday Oct. 28, 29, 30, and 31, 1951, at the Shamrock Hotel, Houston, Texas, under the leadership of President Walter E. Lipscomb, of Houston.

SCIENTIFIC PROGRAM

Meeting called to order by President Walter E. Lipscomb, D.D.S.

Greetings. Irvin A. Worhol, D.D.S., First Vice-President, Houston District Dental Society.

Response. Hugh Sims, D.D.S., Tulsa, Okla.

President's Address. Walter E. Lipscomb, D.D.S.

The D.R. 11 Arch Mechanism in the Treatment of Malocclusion. C. W. Carey, D.D.S., Palo Alto, Calif.

Chairman: A. P. Westfall, D.D.S., Houston, Texas.

A Study of Materials and Techniques for Orthodontic Models. James M. Reynolds, D.D.S., Lubbock, Texas.

Case Report. W. R. Alstadt, D.D.S., Little Rock, Ark.

Demonstration and Clinic. C. W. Carey, D.D.S., Palo Alto, Calif.

Chairman: A. P. Westfall, D.D.S., Houston, Texas.

Tuesday, Oct. 30, 1951

Indoctrination Breakfast—Venetian Room, Hotel Shamrock. Newly elected members will meet with the Indoctrination Committee for explanation of the ideals and purposes of this Society.

An Individual Norm Concept of Occlusion of the Teeth. John R. Thompson, D.D.S., Chicago, Ill.

Chairman: Leo A. Rogers, D.D.S., Hutchinson, Kan.

Intraoral Structures and Pharyngeal Movements. Veterans Administration Film, presented by Spence A. Hutt, D.D.S., Chief of Dental Service, Houston, Texas.

Research Studies on the Temporomandibular Joint and Their Clinical Application. John R. Thompson, D.D.S., Chicago, Ill.

Chairman: J. Victor Benton, D.D.S., Wichita, Kan.

General Clinics.

Wednesday, October 31, 1951

Functional Analysis of Malocclusion. John R. Thompson, D.D.S., Chicago, Ill.

Chairman: Bibb Ballard, D.D.S., Dallas, Texas.

Business Meeting. (Members only.)

Installation of Officers.

Reception and dinner dance honoring President and Mrs. Walter E. Lipscomb was held at the Shamrock Hotel, Monday evening, October 29.

The officers in charge of the meeting were:

President

Walter E. Lipscomb, Houston, Texas

President-Elect

Dan C. Peavy, San Antonio, Texas

Vice-President

Clarence W. Koch, Little Rock, Ark.

Secretary-Treasurer

Marion A. Flesher, Oklahoma City, Okla.

Cincinnati Dental Society

The Cincinnati Dental Society announces that The Cincinnati Dental Society March Clinic Meeting and Children's Dental Health Day will be held at the Netherland Plaza Hotel on March 23, 24, and 25, 1952.

Naval Dental Corps News

Rear Admiral A. W. Chandler, DC, USN, Inspector General, Dental, Bureau of Medicine and Surgery, Washington, D. C., returned to Washington last Thursday after completing a thirty-seven day around-the-world flight inspection tour of Naval dental activities. The Admiral was accompanied as far as the Philippines by Captain Clay A. Boland, DC, USNR, Head of the Reserve Branch in the Dental Division and by his administrative Assistant, Lieutenant Commander J. J. Jacobs, MSC, USN.

After inspecting the dental departments in Hawaii, Kwajalein, Guam, and Japan, the Admiral and his party spent several days in Korea where they inspected the dental department aboard the Naval Hospital Ship, *USS REPOSE*, and the dental facilities with

the U. S. Marines First Division during their recent offensive north of the 38th parallel. Before leaving Japan for the Philippines via Okinawa and Formosa they observed the dental research being done at the Atomic Bomb Casualty Commission Headquarters in Hiroshima.

Returning to Washington via Europe Admiral Chandler had a conference with the Naval Staff Dental Officer in London, England, and inspected the dental departments in Argentina, Newfoundland, and Quonset Point, R. I.

The Inspector General, Dental, found high morale among the dental personnel at all activities. The Commanding General of the First Marine Division spoke with high praise of the efficient medical and dental services, as did all of the commanding officers of the Naval establishments visited.

(Home Addresses: Admiral Chandler, Newark, N. J.; Captain Boland, Falls Church, Va.; LCDR Jacobs, Silver Springs, Md.)

Army Returns Handicapped Veterans to Full Duty Positions

More than 1,500 handicapped veterans of World War II and the fighting in Korea have been returned to full duty positions since November, 1946, the Department of the Army announced today in connection with observance of Employ the Physically Handicapped Week.

Amputees and other disabled personnel who have been rehabilitated and reassigned to full-time Army jobs in the United States and overseas include staff officers, administrators, combat training instructors, engineers, postal clerks, typists, finance officers, intelligence experts, small arms repairmen, and a host of other critically needed specialists.

"You forget these men are wearing artificial limbs," according to Colonel Maurice J. Fletcher, director of Army Prosthetics Research. "They are perfectly capable of doing almost any job. The rarity is to find a job which they can't do. One inescapable conclusion drawn from the rehabilitation program of the Army Medical Service is that no new 'soft' jobs need be created for men who have suffered physical impairment in combat."

For many veterans of the Korean fighting, such as First Lieutenant William F. Coghill of Nenana, Ala., who lost a leg, disability has meant taking up a challenging new specialty. Lieutenant Coghill will attend the Army Finance School this winter and is slated for full duty assignment at Fort Sheridan, Ill., after graduation.

For others, Korean veterans, amputations have caused no change in career plans. Sergeant Alfonso Spencer, of Redhouse, Va., who wears an artificial hand, has been reinstated to full duty as an Army machine shop mechanic, the same work he did as a civilian. Sergeant Marshall J. MacMillan, an expert in cryptography, who lost a leg, works in the coding room at Fort Benning, Ga.

One of the Army's most enthusiastic proponents of retaining handicapped men is himself a leg amputee. Lieutenant Colonel Kenneth E. BeLieu, of Portland, Ore., who has returned to his pre-Korean post as military assistant to Assistant Secretary of the Army Karl R. Bendetsen, has helped many other disabled veterans to find suitable Army assignments upon leaving the hospital.

Colonel BeLieu, like First Lieutenant Marvin B. Tarter, of Union, Ore., who is also serving in the Assistant Secretary's office, was reinstated in the Army without any limitation on his duty assignments except for extended field tours involving prolonged walking. Both he and Lieutenant Tarter, a leg amputee, are confident they could handle combat staff jobs with ease.

At the Prosthetics Laboratory at Walter Reed Army Medical Center in Washington, D. C., there are many amputees, including First Lieutenant Albert Clark, of Portsmouth, N. H., and Sergeant Arthur D. Eckhoff, of Petersburg, Ill., who have chosen to work with others of their kind in testing prosthetic devices. Lieutenant Clark, awarded a Silver Star for action in Korea, is again working as an engineer. First Lieutenant Daniel Dennehy, of Union City, N. J., a hand amputee, is supply and property officer at the laboratory.

Warrant Officer John Shimoda is typical of hundreds of amputees who have returned to overseas assignments despite disability. He is now on full duty in Japan. First Lieutenant Robert Engelien is serving with a Field Artillery unit in Salzburg, Austria. Both men are leg amputees.

Captain Arthur J. Hilly, another leg amputee, recently took on the exacting job of group instructor of a Reserve Officer Training Corps unit at Salt Lake City, Utah.

Federal Security Agency, Children's Bureau, Washington, D. C.

Publication of the ninth edition of *Infant Care*, the Government's baby book and its best seller, was announced today by Dr. Martha M. Eliot, chief of the Children's Bureau, Federal Security Agency.

Sometimes called the "mother's bible," *Infant Care* has been published by the Children's Bureau since 1914 and has grown to a distribution of more than 28,000,000 copies. It has been translated into 8 languages. The Government Printing Office, which sells *Infant Care* at 20 cents per copy, has become accustomed through much use, to requests for it from people who ask simply for "the book."

This popular bulletin has undergone major changes since it was first published in 1914. During its lifetime, advances in medicine, science, and in what we know about the emotional development of children have altered much of the philosophy which the book carries.

Like its predecessor, this edition of *Infant Care* is an attempt by the Children's Bureau to bring together the best known and most widely accepted modern ideas about what is good for children from birth to their first birthday.

National Committee for the Katharine F. Lenroot Dinner

For further details, contact Mrs. George R. Ellison, Publicity Chairman,
National Education Association,
1201 Sixteenth St., N.W.,
Washington, D. C.,
DISTRICT 4552.

The woman who put across the idea that there is "a public responsibility for everybody's children" got her valedictory in Washington this week.

For Katharine Lenroot, third chief in the history of the Children's Bureau, hundreds of men and women who had known her both personally and professionally gathered in the Mayflower Hotel to pay tribute to her "life of service to children."

One of the speakers, Mrs. Eleanor Roosevelt, suggested that despite Miss Lenroot's announced retirement from public service, her job for children is not yet done.

"I believe we have come to a point," said Mrs. Roosevelt, "where I think we are ready to do a job (for children) in a wider field. I think Miss Lenroot has started us on the road to taking an interest in doing that job." It is a colossal job—of fostering international cooperation and doing something for the improvement of the care and health of children throughout the world.

"I can think of nothing more exciting than developing international cooperation in this field. I can think of no one," Mrs. Roosevelt told Miss Lenroot, "who can do it better than you."

Miss Frances Perkins, Civil Service Commissioner and former Secretary of Labor, who credited Miss Lenroot with emphasizing "public responsibility for everybody's children," called her a pioneer and a "distinguished civil servant."

Dr. Martha M. Eliot, who has succeeded Miss Lenroot as chief of the Children's Bureau, expressed her gratitude for the "guidelines" Miss Lenroot has laid down, "for her example of sure judgment, prompt decision, unfailing enthusiasm and courage."

Praise came also from Leonard W. Mayo, director of the Association for Crippled Children of New York City. Miss Perkins, in introducing Mr. Mayo, called him a "wheel horse of the Children's Bureau." Mayo declared that by the testimonial dinner honoring Miss Lenroot, "we are posting for posterity an expression of highest respect, appreciation and affection for the life and work of a great woman whose integrity, steadfastness and devotion have added immeasurably to the lives of the nation's children."

Mr. Mayo pointed to the "significant development" of private child welfare and family agencies in the last four decades and added "there is ample evidence that a great number of knowledgeable and thoughtful people wish to see a partnership between the public and private forces in child care of a character which only a democratic society can provide."

Ernest M. Howell, of the Young Adult Council of the National Social Welfare Assembly, Inc., praised Miss Lenroot for her recognition that "youth participation is valid, not simply because it prepares youth to be more effective adult citizens, but also because young citizens have particular insights and direct contributions toward the solution of today's problems."

Miss Lenroot, in responding to these plaudits, outlined her personal credo for improving human relations in this country and with people of other lands. Among the points she emphasized were: "That human personality is the only vehicle for the service of God and that such service must be freely given and cannot be compelled by either human or divine authority. . . . That full and free discussion of issues is the only safeguard for democracy. . . . That scorn for or exploitation of any group cannot to tolerated in a free society. . . . The road we have travelled has often been darkened by uncertainty as problems have multiplied and the complexity of life and of Government has increased. Many obstacles of indifference, misunderstanding, and open opposition have been encountered. Most of all, we have found hindrances and limitations within ourselves. Only one who has carried responsibilities through the years can appreciate fully how many times opportunities have been missed, people have been misunderstood or ignored, issues have been confused, and leadership has faltered. One of the greatest tragedies in the life of an administrator is that he often feels that he has to play a role, to maintain a front, to assume a competence, and that he does not dare to break out of that artificial shell and let his staff members, his associates, or his public know what he is really like inside. Many of you remember a little book written by a great pediatrician, called *Babies are Human Beings.* Perhaps if someone were to write a book called 'administrators are human beings,' some of the barriers between officials and citizens might be broken down. And perhaps a companion volume, called voters and critics are human beings, might help the administrator to understand better the citizens whom it is his charge to serve, and whom he sometimes finds it hard to tolerate," she said.

Mrs. Theodore O. Wedel, Chairman of the National Committee for the Katharine F. Lenroot dinner, told those who attended the Mayflower function October 3 that plans are being made by Miss Lenroot's friends to sponsor a Katharine F. Lenroot scholarship to be used for the training of young people in the field of social work.

American Dental Association

The 1951-1952 campaign for contributions to the American Dental Association Relief Fund was officially launched throughout the nation on October 15 with the mailing of the A.D.A. Relief Seals to all members of the dental profession.

Because of the increasing amount of relief which must be provided for needy dentists, the A.D.A. Council on Relief is asking every dentist to be even more generous this year in his contribution to the Relief Fund.

Each contribution will be utilized to help those dentists who, because of illness or other unforeseen disaster, are unable to provide the bare necessities for their families and themselves.

Last year, dentists throughout the nation contributed a total of $91,404.49 to the A.D.A. Relief Fund and the relief funds of their respective state dental societies. The average was approximately $1.40 for each member of the A.D.A.

The national quota for this year's campaign has been set at $100,000. Dr. Leo W. Kremer, chairman of the Council on Relief, expressed confidence that dentists throughout the nation would meet and exceed this quota.

As in former years, the contribution will be divided equally between the A.D.A. Relief Fund, which pays one-half of all relief grants, and the Relief Fund of the state society of which the contributor is a member. All contributions should be sent to the A.D.A. Relief Fund, 222 East Superior St., Chicago 11, Ill.

This year, more than ever, the generosity of the dental profession is needed, Dr. LeRoy M. Ennis, Association president, declared, as he asked the help of every member of the A.D.A. in making this year's fund drive a success.

Relief grants are made under a perpetual trust established by the dental profession and supported solely by voluntary contributions. The trust can function only so long as it has the generous support of each dentist.

As a result of your contribution, the distressed members of your profession can be assured that they will receive the assistance which they so urgently need.

Mail your contribution now to the American Dental Association Relief Fund.

Notes of Interest

Spencer R. Atkinson, D.D.S., announces as his associate Ruth Allen, D.D.S., in the exclusive practice of orthodontics at 65 North Madison Ave., Pasadena 1, Calif.

T. M. Graber, D.D.S., M.S.D., Ph.D., announces the opening of offices at 723 Elm St., Winnetka, Ill., practice limited to orthodontics.

Alan Jackson, D.D.S., announces the opening of offices at 712 Huntington Bldg., Miami, Fla., practice limited to orthodontics.

Charles S. Jonas, D.D.S., announces the removal of his offices to The Mayfair, Albany and Atlantic Aves., Atlantic City, N. J., practice limited to orthodontics.

Dr. James D. McCoy, of Beverly Hills, Calif., announces a change of address to 132 Lasky Drive, Beverly Hills, Calif.

Dr. Francis M. Murray is pleased to announce that Dr. Thomas J. Blackwood, Jr., is now associated with him in the practice of orthodontics at Suite 705, Medical Science Bldg., 1029 Vermont Ave., Washington, D. C.

Erratum

The following contributions from the University of Illinois were omitted from the list of University Clinics held at the meeting of the American Association of Orthodontists in Louisville, Ky., April 24, 1951, which was published in the June issue of the JOURNAL:

1. Craniofacial Proportionality in the Horizontal and Vertical Planes; a Roentgenographic Study in Norma Lateralis. B. H. Williams, D.D.S., University of Illinois.
2. Distinctive Features of the Temporomandibular Joint in Class III Malocclusion. Robert M. Ricketts, D.D.S., University of Illinois.
3. Growth Behavior of the Human Bony Profile as Revealed by Serial Cephalometric Roentgenology. Milton J. Lande, D.D.S., University of Illinois.
4. Serial Growth Study of Newborns With Cleft Lip and Cleft Palate. Samuel Pruzansky, D.D.S., M.S., University of Illinois.
5. Effect of Surgical Removal of the Condyle on the Growing Mandible: An Experimental Study in the Macaca Rhesus Monkey. Bernard G. Sarnat, M.D., D.D.S., and Milton B. Engel, D.D.S., M.S., University of Illinois.
6. A Study of Sutural Facial Growth by Means of Metallic Implants in the Macaca Rhesus Monkey. Benjamin J. Gans, D.D.S., and Bernard G. Sarnat, M.D., D.D.S., University of Illinois.

OFFICERS OF ORTHODONTIC SOCIETIES

The AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

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Southwestern Society of Orthodontists

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Secretary-Treasurer, Marion A. Flesher - - - Medical Arts Bldg., Oklahoma City, Okla.

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